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THE TELEGRAPHIC JOURNAL AND
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VOL. XIV.—NO. 341.

PRIME MOTORS.

THE employment of engines of small dimensions for various purposes is at the present time very extensive, and is likely to increase considerably in the not distant future. A revival in the electric lighting industry, which is sure to come sooner or later, will stimulate the demand for small prime motors. The extent of this demand will, to a great extent, be governed by the class of wares which the manufacturers are prepared to supply. For many purposes the steam engine is but ill adapted, but where a continuous and large supply of power is required it will assuredly hold its own, and in many cases' where a comparatively small horse-power is all that is required, and where the expense and necessity of an attendant is not considered a drawback, steam engines must continue to be used. Water motors are, perhaps, the handiest of all engines, but it is not everywhere that good water pressure is to be had, and when it is to hand it can only be most profitably used where the work to be performed is of an intermittent character, as, for instance, in working cranes and lifts. Gas engines, which continue to come so extensively into use, stand next to water motors in respect of convenience, as they, like the water motors, can be started and stopped at any moment, and as they consume no fuel when at rest, their economy for special purposes is considerable. Hot-air engines do not seem to make very much progress, though they are looked upon with a certain amount of favour. Like gas engines they consume rather a large quantity of lubricants, and, for their size, are not productive of great power compared with steam engines; they have the advantage of not requiring a boiler, and they are, of course, independent of a gas supply. Another class of engine to which but comparatively little attention seems to have been directed, is that in which the motive power is obtained from a gaseous mixture formed from air and the vapour of petroleum or some other hydrocarbon oil. For convenience and portability such engines could hardly be surpassed, and the fact that they have not come into general use would indicate that all the details necessary to make them a success have not yet been worked out. One of the principal difficulties experienced in engines of the type in question is the fouling of the various parts from the deposit of carbon, which gradually takes place as a consequence of the ignition of an oil which is rich in this substance. This difficulty is, no doubt, a serious one, but it is probably one which will eventually be completely got over, and should it be so these engines will, we believe, be very extensively employed, considering the extreme and obvious advantages which must be inherent in them, one of the most important of these being the exceedingly low cost of working.

PRIMARY BATTERIES FOR ELECTRIC LIGHTING.*

MR. PROBERT commenced his lecture by alluding to the first production of the electric light by Sir Humphrey Davy in 1802, and he exhibited one of the original cells employed by Davy on that memorable occasion. But these old batteries were not constant, this defect being due to polarisation, or the deposition of hydrogen gas upon the copper plate.

In the working of a battery, says Mr. Probert, the zinc plate is oxidised and transformed into sulphate of zinc by the sulphuric acid in which the plates are immersed. At the same time, hydrogen gas is liberated on the surface of the copper-plate, where it collects and forms a layer of appreciable thickness, which offers considerable resistance to the transmission of the electric current. It also gives rise to an electromotive force opposed in direction to that of the copper zinc couple. The effect of the polarisation of the battery is then to considerably reduce the current flowing, and worse than this, the amount of deposited gas varies with time and other circumstances, and the current likewise varies. Such a battery, when used to produce the electric light, furnishes a light of constantly varying intensity which is extremely painful to use, and possesses other drawbacks also.

It is evident then that a battery, to be of any use for practical electric lighting, must be capable of generating a constant current. It should also possess these other qualifications, viz., a high and constant electromotive force, and a small and constant internal resistance. It should consume inexpensive materials, and should consume nothing when it is producing no current. It should be capable of being easily cleansed, and of being supplied with fresh materials. It should require no skilled attendance. Unfortunately, no battery hitherto invented possesses all the required qualifications.

Of all the points enumerated, the power to furnish a constant current is the most important. As the want of constancy of a battery is due very largely, although not exclusively, to the deposition of hydrogen gas upon the copper plate, inventors naturally turned their attention to the devising of methods of ridding the battery of this objectionable feature. Mr. Alfred Smee was very early in the field; he found that by roughening the copper plate, the disengagement of the bubbles of hydrogen from its surface was greatly facilitated. The gas, instead of forming a smooth layer upon the copper, collected upon the rough portions, and was discharged upwards through the liquid in streams.

On further investigating the subject, Smee found that it was not necessary that these roughenings of the surface should have appreciable size. He therefore abandoned the copper plate, roughened mechanically, with which his earlier experiments were performed, in favour of a platinum plate, coated with a deposit of very finely divided platinum, obtained by exposing the plate to the action of solution of chloride of the metal, under the influence of the galvanic current. In our own day, platinised silver is often, through a false idea of economy, substituted for the platinised platinum.

Smee's method of eliminating the ill-effects of the layer of hydrogen was but a method of removal, and the question naturally presented itself to the minds of inventors whether a method of prevention could not be devised. An answer in the affirmative was given by Professor J. F. Daniell, of King's College, who invented a battery which remains to this day unequalled in constancy.

This battery, the prototype of all chemical depolarising batteries, is worthy of attentive study. In it the hydrogen, instead of being deposited upon the copper plate, is oxidised to water by the solution of copper sulphate, and metallic copper in place of hydrogen is thrown down upon the copper plate. Polarisation is thus entirely prevented.

If constancy of current were the sole requisite of a battery for electric lighting, the Daniell battery would be admirably suited to the purpose, but it will be remembered that a high electromotive force and a low internal resistance are also essential, and here the Daniell battery fails. The electromotive force of any copper zinc couple is low, and the internal resistance of the Daniell cell is high. The electromotive force might be raised by the device suggested by Daniell of employing platinum in place of copper, and a solution of chloride of platinum in place of the solution of sulphate of copper, but the expense would militate against the practical success of such an arrangement.

It was reserved for Grove—now the Hon. Sir W. R. Grove, one of her Majesty's Judges, but then Professor of Chemistry at the London Institution—to overcome this difficulty, and to produce a chemical depolarising battery of high electromotive force, low internal resistance, and employing a comparatively cheap depolarising liquid. Daniell, as we have seen, had appreciated very clearly the advantage of a platinum plate, but his mind seemed so engrossed with his original idea of a metallic solution, as depolariser, which in decomposition deposited upon the plate dipping into it a layer of the same metal, that the possibility of finding a non-metallic depolariser does not appear to have suggested itself to him. Grove, however, saw this possibility, and by the substitution of strong nitric acid for the metallic solution, achieved the success which Daniell had vainly sought for. For the first time, the production of the electric light by the aid of a primary battery became possible on a practical scale; and in the very year of Grove's invention, the electric light was used for theatrical purposes, at the Opera House, Paris.

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* Paper read by Mr. Isaac Probert before the Society of Arts, May 28th, 1884.

Suggestions by Cooper, Walker, Bunsen, and Archereau, quickly followed, and in the course of a few years the nitric acid battery had assumed its present convenient form.

Why is it that a dynamo-electric machine should be almost universally preferred to a voltaic battery for the production of the electric light? It is a question of cost—of the relative cost of the two methods of producing an electric current. Let us examine this point a little in detail.

Both in a voltaic battery and in a dynamo-electric machine, the electric energy is ultimately referable to combustion, or, more strictly, to chemical combination. In each there is a combustible substance, oxygen or an equivalent substance, to sustain the combustion, and the means wherewith to collect and utilise the energy liberated. In a voltaic battery, the combustible substance is usually zinc, and the oxygenous substance sulphuric acid. In a dynamo-electric machine—or rather in the furnace of the engine that drives it—the combustible substance is coal, and the oxygenous substance air. The question, therefore, as ordinarily presented, resolves itself into this:—Required a certain quantity of electric energy; can it be more economically produced by burning zinc in sulphuric acid in a voltaic battery, or by burning coal in air in the furnace of the engine of a dynamo-electric machine. In answering this question, we must consider the relative cost of zinc and coal, their thermal equivalents—that is, the amounts of heat obtainable by the combustion of equal weights of the two materials; the efficiency of the battery and the engine and machine—that is, the proportion of useful work obtained to the total energy generated; the cost of the oxidant of the zinc—air, the oxidant of the coal, costing nothing; the relative cost, both original and for maintenance, of the battery and the dynamo and engine; and the relative cost of attendance. In the case of the battery, there is also the possibility of the utilisation of the bye-products to be considered.

To make the matter quite clear, let a practical illustration be taken. Let it be supposed that a house has to be lighted by a hundred incandescence lamps, each requiring a current of ·75 of an ampère urged by an electromotive force of 100 volts. The energy that has to be developed by the engine is greater, for no dynamo-electric machine is perfectly efficient, no dynamo machine gives out as electrical energy the exact equivalent of the mechanical energy expended upon it. Let it be supposed that the machine used in our installation has a "commercial efficiency" of 80 per cent., that is, that 80 per cent. of the mechanical energy put into the machine reappears in the external or lamp circuit as electrical energy, the balance being wasted in heating the armature coils, and the friction of axles, slipping of belts, and other mechanical sources of loss. Then the rate at which energy is generated by the steam-engine must be 10·05 × 1·25, that is 12·55 horse-power. Unfortunately, steam-engines, even of the best make, have but low efficiency, and a horse-power-hour of energy requires in practice somewhere about 4½ lbs. of coal for its production; 12·55 horse-power-hours will therefore require about 56½ lbs. of coal—say, roughly, half-a-hundredweight, the cost of which is not more than 6d. Assuming that the lamps were required to burn for 1,800 hours a year—that is on an average nearly five hours a day—the annual cost for coal would be £45. The prime cost of a suitable dynamo machine and engine (with boiler) would be, say, £300, the interest on which, at 4 per cent., would be £12, and the annual depreciation, at 10 per cent., £30; the cost of attendance would be about £60, so that the prime cost would be £300, and the total annual cost £147, or £1 9s. 5d. per lamp.

If a galvanic battery is used to supply the current to the lamps, the energy will require to be produced at a rate of somewhere between 10·05 and 20·1 horse-power, for the efficiency of a galvanic battery depends upon the relation subsisting between the resistance of the battery itself and the resistance of the external circuit. As a matter of practice it becomes advisable to arrange the resistances so that the external is greater than the internal, whereby the efficiency of the battery is made to as nearly approach a hundred per cent. as we wish. Let it be supposed that in our installation the efficiency is, as in the dynamo just considered, 80 per cent. To liberate a horse-power-hour of energy, a quantity of zinc must be oxidised equal to 2·022 lbs. divided by the electromotive force of the galvanic couple in use. It is calculable that the highest electromotive force obtainable in any zinc sulphuric acid battery is 2·248 volts, from which, however, a deduction must be made on account of the energy absorbed in the chemical action of depolarisation. The amount of the deduction will depend upon the nature of the depolariser: with nitrate of soda and sulphuric acid it is ·708 volt, with bichromate of potash it is ·343 volt, and with fuming nitric acid ·284 volt. In order to do the fullest justice to batteries, let it be assumed that strong nitric acid is the depolariser used in our installation. The deduction to be made from the total electromotive force of the battery is, therefore, ·284 volt, and the net electromotive force of the battery is 1·964 volt, which corresponds to a consumption of 1·03 lb. of zinc per horse-power-hour of energy. To liberate 12·55 horse-power-hours, 12·93 lbs.—say 13 lbs.—of zinc must be used. If the price of zinc be taken at 2½d. per lb., the zinc used per hour costs 2s. 8¼d. But the expense does not end here. Air, the oxidant of coal, costs nothing; whereas sulphuric acid, the usual oxidant of zinc, is of considerable value, costing, even on the commercial scale, ¾d. per lb.

To oxidise a pound of zinc, 1½ lb. of sulphuric acid is required, as is shown by the equation, $Zn + H_2SO_4 = ZnSO_4 + H_2$. To oxidise 13 lbs. of zinc, 19½ lbs. of acid are therefore required, which costs 1s. 2⅝d.; this, added to the cost of the zinc, makes about 3s. 11d. But we cannot stop even here. In order that the zinc may give the greatest possible return of energy, the electromotive force of the voltaic arrangement must, as has been stated, be high, and this—as a net result, at least—can only be obtained by the aid of a good depolarising liquid. We assumed ourselves to be using strong nitric acid, and if we suppose that the average effect of nascent hydrogen upon this substance is to produce nitric oxide (N_2O_2), the amount of acid required will be shown by the equation, $2\,HNO_3 + 3\,H_2$ (equivalent to $3\,Zn$) $= N_2O_2 + 4\,H_2O$. It follows, therefore, that the solution of every pound of zinc is accompanied by the deoxidation of ⅔ lb of nitric acid. In the production of 12·55 horse-power-hours of energy, 8⅔ lbs. of nitic acid will therefore be deoxidised, the cost of which, at 6d. per lb., is 4s. 4d. This, added to the cost of zinc and sulphuric acid, gives 8s. 3d. as the total cost of materials.

But we have not yet done. A battery cannot be charged, and then kept in action until every grain of zinc, and every drop of acid have been consumed. It has been found by experience that no more than about 20 per cent. of the acid can be utilised. When this proportion has been used, the battery begins to flag, and is soon of no further use for electric lighting until the solution has been changed. The greater part of the acid is thus removed as spent solution. But neglecting this source of waste for the moment, and assuming that by a careful process of "refreshing" it is possible to completely exhaust the acid solution, let us see what the cost of our 10·05 horse-power is when generated by a galvanic battery. We have seen that the cost of materials per hour is 8s. 3d., and assuming, as before, that the light will be required for 1,800 hours a year, the annual cost for materials only is £742 10s. The prime cost of the battery may be taken at £120, the interest, at 4 per cent., on which is, say, £5, and the annual depreciation, at 10 per cent., is £12. The cost of attendance is very difficult to determine. It is claimed by the inventors of batteries that the cost is very small; they say that no skilled attendance is required, and this seems reasonable; and that there is nothing further to do than might be done by a domestic servant in the ordinary course of his duties. Let us assume that this is so, and that the cost of attendance is so small as to be negligible.

If we divide the total annual cost (that is £759 10s.) by the number of lamps, the annual cost per lamp is found to be £7 11s. 8d., as against £1 9s. 5d., when a dynamo machine is used. The difference is great, but it becomes even greater when we remember that it is never possible to completely use the acid solution.

From what has been said, it will be gathered that, in a comparatively large installation such as has been sketched, primary batteries have little chance of success; but for smaller installations, of, say, 10 to 20 lamps, there may, perhaps, be a field of action open to them. Few people occupying a house requiring so few lamps as this would incur the trouble of a dynamo and engine, although for health's sake they might not object to the cost of the light as produced by a battery.

In what way is it possible to reduce the cost of electric lighting by galvanic batteries? It is evident that there are four ways open; and invention has been active in all. In the first place, a cheaper oxidisable substance than zinc may be employed; and in the second, possibly a cheaper oxidant than sulphuric acid. Next, contrivances may be adopted by which the solutions are more completely exhausted; and lastly, the bye-products—the substances formed during the action of the battery—may be utilised in the arts.

In the first place, as to the oxidisable substance:—Zinc is almost universally employed, but lead and iron have been suggested, and a battery using the latter substance is now before the public.

Next, as to the oxidant, or, speaking more generally, the solvent of the positive element of the cell:—Sulphuric acid has been replaced, among other substances, by hydrochloric acid, and the battery employing this liquid has been introduced by Mr. Ross.

As to the bye-products, little can be said, except that the less said the better. Some promoters of patent batteries make a great point of the value of the bye-products of their batteries, but, as a matter of fact, their statements on this point will seldom bear investigation. A zinc residue contains a certain percentage of the metal in a state of chemical combination, from which it has to be recovered by a somewhat costly process, and one hardly likely to afford any profit to the person using the battery.

It may be interesting to notice that, in the Telegraph Department of the Post Office, no residues are thought worth preserving, except the "black mud" (technically so-called) from the Daniell cells, which contains a very large percentage of pure copper in the metallic state. Last year there were 69,323 Daniell cells in use, and the sum realised by the sale of the year's "black mud" was £167 14s., or rather more than a halfpenny per cell per year. An idea may be formed from these figures of the magnitude of the sum likely to result from the sale of the zinc residues—which in the Post Office are thrown away as worthless—in the case of an ordinary householder using some 10 or 20 cells.

During the last few years several batteries especially designed for use in electric lighting have been devised, and these batteries may be divided into two classes; those in which the liquids are kept in motion, and those in which they are allowed to remain in a state of quiescence. Of the latter, one of the most important is that devised by Messrs. Holmes and Burke. A description which these gentlemen have been good enough to furnish reads thus:—

"Each battery of eight cells can be charged or discharged at two operations, by means of a system of syphons formed partly in the substance of the outside cells. In order to charge the battery it is only necessary to fill a wooden measuring vessel with the exact quantity of fluid necessary to run into the battery, to connect this vessel with the long leg of one of the syphon systems, and to raise the vessel to a certain height, when the liquid immediately distributes itself amongst the cells, and is bound to attain a uniform height in each of them. To discharge the battery, it is only necessary to reverse the process.

"The fumes are collected and suppressed. The porous pots are sealed into wooden covers, which contain passages for the escape of fumes. The passages communicate with one main pipe formed in the substance of the cells, and the fumes can thence be led away to the fume box, where they are either dissolved or chemically absorbed, according to circumstances.

"The connections between the cells are so simple that they can never be coupled up wrongly, and they are placed beyond the reach of injury by acids or fumes. They never require disconnection when the battery is discharged or re-charged. They require partial disconnection when the plates have to be amalgamated, but the latter, when once thoroughly amalgamated, hardly ever require re-touching. Plates have been run for two months without re-amalgamation.

"The depolarising liquid is cheap and easily handled. It is made of nitrate of soda dissolved in solution of sulphuric acid of a particular strength. It depends for its action on the formation by the current of nitric acid in the porous pot. The hydrogen entering decomposes the nitrate of soda by the aid of the acid, forming sulphate of soda and nitric acid. The liquid is of very good conductivity, and as the nitric acid is only formed as it is wanted, the inconvenience of handling this very disagreeable acid is avoided.

"The cost of the liquid is only 5½d. to 6d. per gallon. Each gallon furnishes from 750 to 800 ampère-hours of electricity at an electromotive force of 1·92 volt—*i.e.*, about 1,536 watts, or very nearly two hour horse-power.

"The internal resistance of the battery is very low for a primary cell, and equals ·02 ohm. as nearly as possible."

It may be added that, like the generality of electric lighting batteries, the batteries of Messrs. Holmes and Burke employ carbon and zinc as the elements.

The battery which next claims attention is that of Mr. O. C. D. Ross. The chief point of novelty distinguishing it is the ingenious arrangement for charging and discharging the depolarising liquid.

The battery itself is enclosed in a box, about 1 ft. square by 7 ft. long, which contains thirteen double cells, the plates in each of which weigh about 10 lbs.; the whole box when charged weighs about 2 cwt. Each cell contains two carbon plates (formed of ½-in. carbon rods placed side by side) which are immersed in dilute hydrochloric acid mixed with one-sixth of its bulk of a mysterious compound, called by Mr. Ross "Eureka," but which might doubtless be replaced, without materially affecting the action or the cost of the battery, by nitric acid. The zinc plates dip into a solution of common salt, the liquids being kept apart by porous partitions. The mechanical arrangement by which the carbon cells are filled and emptied is very simple; a horizontal pipe connected by flexible tubes to the bottom of each inner cell is raised or lowered; one end is attached by a flexible tube to a cask of acid, and the other end is led to a waste tank. When the horizontal pipe is raised, and communication with the waste tank cut off, the acid flows, on turning the tap of the acid cask, into the inner cells. When spent liquid is required to be removed, the horizontal pipe is lowered, and the liquid flows from the cells to the waste tank. The outer cells are filled with solution of salt, in one operation, by pouring the solution into a groove extending the whole length of the box, and connected by side passages with the cells.

The Ross battery has been examined by Dr. Hopkinson, who reports that:—

"Comparing this battery with others, a great deal may be said in its favour.

"Its constancy with a large current is remarkably good.

"The liquids used in the cells are less expensive than in any battery having any pretence to constancy.

"Mr. Ross's method of drawing off and replenishing the liquid is very convenient."

The electromotive force per cell is stated to be 1·82 volt, and the resistance 0·06 ohm.

Another battery, introduced some time back, is that known as the "Edco" or "Heap" battery. It is a carbon-zinc couple using bichromate of potash as the depolariser, and dilute sulphuric acid as the excitant. The cells are lined with lead, and hold each 1½ gallon of the bichromate mixture (which can be purchased ready prepared at 1s. per gallon). The zinc plates are 10 × 6 inches, and so offer a total surface of 120 square inches to the action of the acids; they weigh 3 lbs. each. The electromotive force is stated to be 2 volts. per cell, and the resistance 0·2 ohm. The point of novelty is claimed to lie in the preparation of the bichromate solution, the description of which is best given in the manufacturer's own words. They are as follows:—

"In each lead cell pour six pints of water, and in each repeat the following operation:—

"Fill the colander (which is supplied with the battery) with bichromate of potash, and hang it in the cell so that the crystals are just immersed in the water. Pour about one-fourth of three pounds of sulphuric acid over the crystals in the colander slowly, stopping occasionally when the liquid boils. As fast as the bichromate of potash gets dissolved, add more, and continue pouring in sulphuric acid as before, until there are used up for each cell all of one and a-half pounds of bichromate of potash, and three pounds of sulphuric acid. When the liquid is entirely cool, it is ready for use. . . . This fluid will last twice as long as the . . . fluid ordinarily supplied."

In the other or circulating class of batteries, there is one deserving of notice. It is the invention of Messrs. Oliphant, Burr, and Gowan. It is a two fluid bichromate battery, having zincs coated with an extremely thin film of gold before amalgamation. The exciting liquid is a solution of salts of mercury. The liquids for the outer jars and inner porous pots are pumped out of separate tanks into distinct pipes communicating with the first jar and the first porous pot. They then rise up syphon pipes into the adjoining cell, and flow onwards in this way through the whole series. To avoid any possible stoppage through friction in the pipes, it is advisable to have the first cell one-twelfth of an inch higher than the second, and so on. Thus, in a series of thirty-six cells, the last cell will be three inches lower than the first. The last jar and porous pot are connected to their respective tanks. The tank holding the bichromate solution is fitted as a cell, and works a Griscom or other motor, which causes two small pumps to keep the liquids in constant circulation. The pumps raise two cubic inches of liquid per stroke, and work at the rate of thirty strokes per minute. The pumps are constantly at work day and night, whether the battery is in use or not.

The effect of gilding the zincs before amalgamation is, it is stated, to materially decrease local action.

Many other batteries might be described, and it may be interesting to note that, during the past three years, about 150 patents for improvements in primary batteries have been applied for in Great Britain alone.

A question which presents itself in connection with the problem of economical lighting by primary batteries is this:—Is it not possible to effect economy in the lamps—to so improve the lamps that a given expenditure of energy on the part of the battery will develop more light in the lamps than is now obtained? Yes; it is possible. It would be troubling you too much to enter here into a lengthy account of the scientific principles which should guide the designer of the luminous conductors of incandescence lamps. It must suffice to say, that the ideally perfect conductor would assume a spherical form: its mass would be very small, and its surface also, and the material of which it was composed would possess the power, possessed unfortunately by no known substance, of enduring without change for an unlimited time the passage of a very powerful electric current. Of all substances hitherto used for incandescing conductors, carbon obtained by the intense heating of a pure hydro-carbon is the best. It will give a greater return in light for a given expenditure of energy, and will withstand the action of the current longer than any other substance. It becomes possible, therefore, by its aid to approach more nearly to the ideally perfect form of luminous conductor than we should otherwise be able to. If also we can so fashion the intimate structure of the carbon, that the particles already have that arrangement which they tend to assume under the action of the current, the type of perfection can be approached even more nearly. This has been done. In a patent obtained in November, 1882, by Messrs. Boullon and Soward, in conjunction with myself, a method was described by which luminous conductors can be obtained of pure deposited carbon formed under the influence of the electric current. By suitable means, these conductors can be obtained of any required degree of approximation to the theoretically perfect form. What thickness they will ultimately assume it is impossible yet to say. The shorter and finer they are made, the greater is the economy, but the shorter is their life. The thickness at which the economy in action is just balanced by the increased cost of renewal of lamps is the practical working thickness, but this can only be determined by lengthy experiments, which are still in progress.

It may be noted in passing that high resistance luminous conductors—and they can be made without difficulty with a resistance of 1,000 ohms and upwards to the inch—have the great advantage that they work with a small current, although they necessarily require a somewhat high electromotive force. This enables the copper leads to be much thinner, and therefore less expensive, than in the case of a low resistance luminous conductor, worked by a large current, which is an important point worth bearing in mind.

Messrs. Woodhouse and Rawson have quite recently introduced a new lamp, which they call their "hair filament lamp." These lamps have an extremely thin, hair-like filament, whence their name. No particulars of the method of manufacturing these filaments have been published, but it appears that, like the filaments of my colleagues and myself, they are made of deposited carbon. The method of their preparation is carefully kept secret, doubtless for fear of piratical imitations, which, although generally easily detected, are yet often hard to prove in a court of law. These filaments are stated to be very efficient. It is said that they will furnish a given amount of light with less than half the expenditure of energy necessary to furnish the same amount in an ordinary thick filament. This is doubtless true; the experiments of my colleagues and myself with our own filaments perfectly support this statement, and we have had the opportunity of experimenting with filaments of much greater length, and therefore light-giving power, than Messrs. Woodhouse and Rawson seem to have had, if a conclusion may be formed from the lamps before the public.

DISCUSSION.

The Chairman, Mr. W. H. Preece, F.R.S., said, when it was remembered that during the last three years no less than 150 patents had been taken out for new primary batteries, no one could wonder that Mr. Probert had only been able to refer to three or four of the number; but he was somewhat surprised that he had omitted all reference to one which had created as much interest as any he had named, one devised by an extremely clever Russian officer, who had unfortunately succumbed to the English climate Mr. Skrivènow.

Mr. Holmes then exhibited a model of his battery, and described its construction and mode of operation. The fumes from the nitric acid were conveyed to a box, where they were either absorbed by a solution of sulphate of iron, or converted by a solution of sulphate of ammonia into nitrate of ammonia. The cost of the nitrate of soda which formed the depolarising liquid, was only £10 a ton, or a little over 1d. per lb., and the total cost of the sulphuric acid solution was from 5½d. to 6d. a gallon, each gallon giving from 700 to 800 ampère hours of electricity.

Mr. Ross next exhibited a model of his battery, and described its mode of action. There was no attention required beyond removing about one-seventh of the liquid each day, and replacing it by fresh acid, which was effected by lowering and raising a tube at the side. For a battery lighting 50 lamps of 20 candle-power, the quantity of liquid required to be drained off each day was about 10 gallons, and smaller batteries in proportion; any domestic servant could manage it without difficulty, and the battery would work for two or three weeks without anything else being done to it; but he arranged for an inspector to go round once a fortnight, and attend to the zinc plates. The liquid was very cheap, being principally water; the outside cells were filled with salt water, and the inside with water and acid, mostly hydrochloric acid, the cheapest in existence, being, even in London, only ⅓d. per lb. In Newcastle it was only 3s. 6d. per cwt., and, in fact, large quantities were taken out to sea in barges, and thrown away; to this was added a very small portion of a solution, the nature of which was a secret. He had made a calculation showing the relative cost of electric lighting by batteries, as compared with gas, and though he did not pretend that the battery could compete with gas, yet the expense of the zinc in the battery was less than the price of gas. The product of a ton of coals—say, 10,000 cubic feet of gas—when burned in Argand burners, would give a light of 30,000 candles for an hour, which, at 3s. per 1,000, would be 30s. Now one ton of zinc would give 1,280 horse-power, which, at the rate of 333 candles per horse-power, would be 426,240 per hour, or more than fourteen times as much light as was obtained from a ton of coal; while the cost of zinc at £18 a ton was only twelve times as much as the 30s. which the gas cost. That was a strong argument against the popular belief that the cost of zinc was absolutely prohibitory of its use in lighting. He did not for a moment suppose that galvanic batteries as now made could compete with dynamos when used on a large scale, because the economy of the dynamo was shown to be very great when used for large installations; but a dynamo could not be put into a cellar, and a battery could.

Mr. Burr next explained the battery made by his firm, which he said had three peculiarities. In the first place, they endeavoured to minimise the destruction of the zinc, by coating it with gold previous to amalgamating with mercury. They had great difficulty in obtaining patents in America and Germany for that process, but ultimately succeeded. Secondly, in place of mercury they employed chloride of mercury, a small portion of which had the same effect, and avoided the bad effects of mercury fumes being given off. The third improvement was due to the late Mr. Spottiswoode, the object of which was to prevent the polarisation of the carbon by the formation of hydrogen bubbles. This was effected by keeping up a circulation in the liquid; Mr. Spottiswoode's suggestion only went to circulating the liquor in the carbon cells, but they found the results so excellent that they applied it to both sets; the circulation being effected by means of syphons, and small pumps worked by a motor, as described in the paper. The solution they found to act best in the carbon cells was 3½ parts, by weight of bichromate of potash, to 1 of sulphuric acid, and 10 of water. For the zinc cells, water only with the addition of about ½ oz. of chloride of mercury was used. This cost 2s. 6d. per lb., and a pound would supply 30 cells for three months. It was necessary to add to the zinc cells about a pint of water every three days, for the water appeared to be consumed far more rapidly than would be accounted for by evaporation. In the carbon cistern was hung a small colander filled with bichromate of potash, and when that got empty you simply had to refill it, and, provided the circulation was kept up, there would be no formation of chrome alum crystals. The cost of the zinc was hardly worth considering. They had worked a battery constantly day and night for 600 hours, and the consumption of bichromate of potash was about 1 lb. per week, while the amount of chloride used was hardly worth mentioning. When they commenced, the bichromate of potash cost 7d. per lb., but it was now reduced to 3½d., and, no doubt, it would come down still further.

Prof. George Forbes said that the merits of the different batteries had been well brought out. He had examined one or two of these batteries, and certainly some had great advantages, but he must say that claims were sometimes put forward by inventors which were not borne out; for instance, the economy which was promised in the consumption of zinc and so forth, had not been found to exist. He must admit that all who had tested this class of primary batteries found that great improvements had been made in the depolarising agent, and especially in the economy of it. The nitric acid which had generally been used was an expensive material, and great economy had been introduced in this respect by more than one inventor. Still more advance was shown in the mechanical improvements which had been made, by which the process of charging and discharging the batteries from day to day had been rendered very simple, and thus a very important obstacle to their use had been removed. He regretted the reader of the paper had not gone more fully into some other batteries introduced, not only in this country, but also on the Continent. For instance, there was the interesting battery of Lalande, in which oxide of copper was used as the depolariser, from which it was hoped considerable results might come. He believed some of the first experiments in using carbon as the positive plate were made by himself in 1879, when he thought he saw a twofold advantage from the consumption of carbon. Since you must consume carbon in a furnace in order to produce steam, and then afterwards convert steam-power into electricity, it seemed much simpler to produce the electricity from the consumption of carbon direct. Secondly, if you could consume carbon to give a fair amount of electromotive force in combination with any other material, the atomic weight of carbon being so small, the weight required to be used would also be very small. Again, considering that in the Bessemer furnace, the carbon consumed the oxygen of the air which was blown in, and the iron did not, it seemed probable that in that case the carbon would be positive to the iron. The first experiment, therefore, was made with black oxide of iron in Professor Crum Brown's laboratory in Edinburgh. The oxide of iron was melted, and a plate of iron and a plate of carbon were immersed in it, and the carbon was found to act as a positive plate. The intense heat required, of course rendered that method useless practically, and he then tried litharge, but found that melted the vessel in which it was put. Then they passed to the use of melted salts, in which the chemical action appeared to be the consumption of oxygen in red-hot water; but that was rather trenching on Professor Guthrie's subject of cryohydrates. These experiments had been carried farther on the Continent, and he thought it would be in this direction that they must look for the next advance, for the consumption of zinc must always be an expensive way of getting electricity. When he heard the figures given of the amount received by the Post Office for the bye-products of their batteries, he could not help asking the chairman whether those products were utilised as well as they might be, and whether they did not get much more for them in Germany.

Mr. Shoolbred asked the size of the battery which had worked continuously for 600 hours.

Mr. Burr said it was a 12-cell battery, and the same cells were on the platform and could be examined, only the porous cells were round instead of square.

Mr. Wharton said he had had a fair amount of experience with one of Mr. Holmes's batteries. No doubt dynamos were more practical things, and he would far sooner use them than batteries, where the installation was of a size of from 100 to 1,000 lights; but if they could approach anything like the economy claimed by Mr. Burr, where water was oxidised, there might be more to be said for the batteries, or if they could succeed in oxidising coal in a battery, and getting a better proportion of the theoretical heat value out of it. With any combination of a steam or gas engine to a dynamo they only got about 4 or 5 per cent., whilst in Mr. Holmes's battery about 60 per cent. of the theoretical efficiency of the zinc was obtained. He had used a battery on many occasions for real practical work, and had found it useful, and far superior to accumulators. On one occasion he lit 48 lamps eight hours a-day for six days consecutively, under a contract; the current was uniform, 65 ampères; the external resistance was constant because he kept the same number of lamps on the whole time, and the fall of potential between the mains was *nil*. That was about as large a practical use of a primary battery as had ever been made, and was for lighting a bazaar in a building underground. If he had used accumulators, he should have had much greater difficulty, more weight to carry, and would have had to bring them back each day to be re-charged. The cost was, perhaps, more than that of a large dynamo and steam engine, but the convenience was very great. Again, for small installations in houses, where one or two rooms only had to be lit, it was quite out of the question to use a dynamo and steam or gas engine, and for such purposes these batteries might be very useful. There was also a great improvement going on in the lamps; a short time ago three watts per candle was considered very good, but the lamps on the table were running at 1·7 watts per candle.

Mr. Ferguson said he had been using the Lalande and Chaperon battery, to which Prof. Forbes referred, for electric lighting; he had one in his office, at 31, Lombard Street, which had been at work without being touched at all for four or five weeks, giving light for about six hours a day. He had sent down a couple of the cells, which were on the table, and if a little more attention were turned to the use of alkalies for these batteries, they would be much improved. The acids made a horrible smell, and there was some trouble in getting rid of the fnmes, but by the use of caustic soda or potash, he thought that might be avoided. He should be glad to show the battery to any one who would call at his office.

Mr. Probert, in reply, said he had not forgotten the Lalande and Chaperon battery, but it only came under his notice the previous day, and he had not had much time to examine it. He could not say anything about the carbon theory; his feeling was that thermopiles would ultimately become the most efficient generators of electricity for domestic lighting. There you certainly had heat transformed directly into electricity, and it seemed to him a much neglected subject which deserved more attention. He would also draw attention to a table lamp of 3-candle power lent by Mr. Smith (Elliott Brothers). The base box contained five small Skrivanow cells of the kind alluded to by the Chairman. This form of battery is a costly luxury, being chiefly used for buttonhole or necktie pin lamps on special occasions. The compounds and elements are chloride of silver, caustic potash, silver and zinc. In conclusion, he desired to mention the fact that the 45 Swan 10 and 12-candle lamps, so artistically arranged by Messrs. Wharton and Down, and so efficiently worked during the evening, derived their enegy from 33 Holmes and Burke cells, the area occupied by each cell being 4 in. by 13 in.

The CHAIRMAN, in moving a vote of thanks to Mr. Probert, having drawn attention to one of Messrs. Woodhouse and Rawson's small lamps attached to a laryngscope, said he must first refer to the question of the waste products in the Post Office. Mr. Probert had referred to 69,000 Daniell cells, but that was but a small part of the total battery power employed; altogether it would be more like 200,000 cells. But the consumption of material in each cell, per annum, was quite insignificant. Taking the maximum current employed for telegraphic purposes, he made out the resulting product for 12 months was only equivalent to that resulting from the production of 30 ampères in one hour; so that the whole product from one cell in a year in the telegraphic service was only half that of one of Mr. Holmes's batteries working for an hour. But the real point was that the cost of collecting the waste far exceeded the amount realised by selling it. In Germany they might do better, because there the railways were practically in the hands of the Government, and carriage was free. He did not take such a pessimist view as some people of the future of primary batteries; there was plenty of room for them, not only where dynamos and secondary batteries were out of the question, but even in economy, as compared with other modes of producing electricity. On the other hand, he could not go so far in their favour as some ardent inventors. One of his duties was to examine inventions, and as he had to inquire into about three a day on an average, it might easily be imagined that he got rather sick of inventions, especially when the same thing was brought forward again and again. The gist of what many of these inventors claimed was to this effect, that their new battery cost nothing; it never required charging; its electromotive force was infinite, and the residuals were of great value; its internal resistance was nothing, and its current absolutely constant; in fact, if Mr. Chamberlain and the Chancellor of the Exchequer availed themselves of the invention, they would very soon pay off the National Debt. It was a pity inventors should go so far as that, but there were some exceptions, and certainly some of the instruments brought forward that evening were really doing very good work. He had seen Messrs. Oliphant, Burr, and Gowan's battery at work after it had been at work for some hundreds of hours; and he had seen one of Mr. Holmes', lighting up a train on the London and South-Western Railway very successfully, and was informed that another was employed on the Midland line. Mr. Probert had brought out the cost of 100 lamps for 1,800 hours, but no one wanted to use a battery for 100 lamps; they wanted a small battery to give a light in a dining-room or a library, where the consumption was very small; or in City offices, where it got dark at 4 o'clock, and they wanted to remain an hour longer. How pleasant it would be to turn on a battery to give that hour's light, instead of having to submit as at present to the poisonous fumes of gas. Mr. Ross had given a curious calculation as to the cost of zinc, as compared with gas, which he should be interested in verifying when he saw the figures in print, but that was not the proper way of estimating the cost of a battery. You must take into account the capital charges, depreciation and renewals, and above all the cost of supervision and attendance; and when all these were examined carefully, it would be found that batteries, though they were very nice for some purposes, were expensive luxuries. Experience was the only test, and he should strongly urge inventors to apply it to their batteries, and bring forward the actual results, showing how they behaved. One of the most important points in connection with this question was the efficiency of the lamps. Edison lamps were used in that hall, and though one would occasionally give in, he believed nine-tenths of those now in use were the same which were originally put up. The efficiency was indicated by the number of watts consumed to produce one candle-hour; the Edson required four; some Swan lamps exhibited that evening required three-and-a-half, and he had recently been experimenting with some of Woodhouse and Rawson's, which only required two, so that in less than two years the efficiency of incandescent lamps had been doubled, and probably, before they met again, some one else would have made a still further improvement.

A Difficulty Overcome.—We observe in a contemporary a notice of an installation of the telephone in the Scilly Islands, between Tresco and St. Mary's. "The distance between the two islands is about three miles, and the line is laid *under the sea*." We presume that this prudent course was adopted in view of the difficulty of successfully establishing an aerial or subterranean line.

THE DEMBINSKI MICROPHONIC TELEPHONE TRANSMITTER.

THIS apparatus, which is shown by figs. 1, 2, and 3, consists of a wooden case, A, of oblong shape, closed by a lid fixed by hinges to the top or one side of the case. The lid is actually a frame for holding a piece of wire gauze, L, L, through which the sound waves from the voice can pass. In the case a flat shallow box, E, F (or several boxes), is placed, on the lid of which the carbon microphone, D, C (figs. 1 and 3), which is of the ordinary construction, is placed. The box is of thin wood, coated inside with petroleum lamp black, for the purpose of increasing the resonance. It is secured in two lateral slides fixed to the case. The bottom of the box is pierced with two openings, resembling those in a violin (fig. 2). Lengthwise across the bottom are stretched a series of brass spiral springs, G, G, G, which are tuned to a chromatic scale. On the bottom of the case a similar series of springs, not shown, are secured. The apparatus is provided with an induction coil, J, which is connected to the microphone, battery, and telephone receiver (which may be of any known description) in the usual manner.

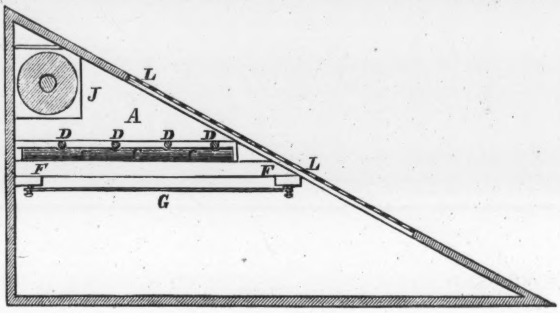


FIG. 1.

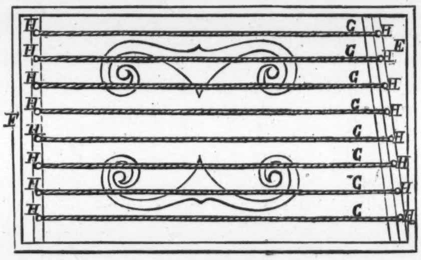


FIG. 2.

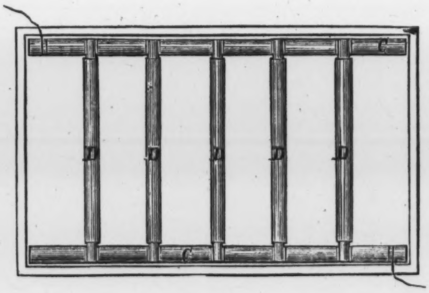


FIG. 3.

The inventors claim that the use of the vibrating springs give to the transmitter an increased power over those at present in use. They state that the instrument has given very satisfactory results between

Ostende and Arlon, a distance of 314 kilometres (about 200 miles). It does not appear, however, that microphones of the ordinary Gower-Bell type, for example, were tried in competition with the new invention, and in the absence of such tests the mere fact that very satisfactory results were obtained over a length of 200 miles proves very little. With reference to a statement that whistling could be very clearly heard, we may remark that experience has many times proved that the most indifferent form of transmitter will almost always respond well and even powerfully to such forms of vibration.

MAGNETIC ROTATIONS.

By E. L. VOICE.

THE remarkable researches and experiments of Professor Hughes clearly show that magnetism is totally independent of iron, and that its molecules, particles, or polarities are capable of rotation in that metal. It would also appear that by reason of the friction between magnetism and iron, the molecules of the latter are only partially moved, such movement being the result of the tendency of iron to retard magnetic change.

I have found that the magnetic molecules also possess inertia, that they are capable of acquiring momentum, and that their rotation continues for a considerable time after the exciting cause of their rotation has ceased.

These facts may be proved in a very evident manner, inasmuch as induced electric currents are generated by this *after* rotation, which may be made to light incandescent lamps.

In this case, the magnetic rotations are produced in an electro-magnet by means of alternate currents supplied by an alternating Gramme machine.

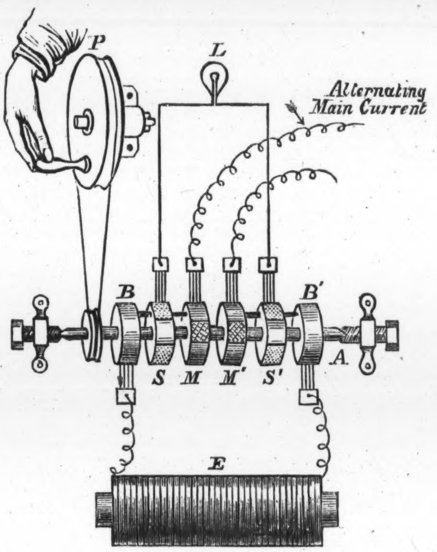
In order to better explain the action, it will be necessary to refer to a new electro-motor, which was the subject of an article in the ELECTRICAL REVIEW of February 19th last. It is of that type of motor in which the field-magnet and armature poles are alternately arranged, and which requires a periodical reversibility of magnetism in the armature to cause the latter to revolve, as in the Griscom motor. The insulating strips in the commutator are sufficiently wide to demagnetise the whole of the machine before reversibility in the armature takes place, and this demagnetisation sets up a *direct* induced current, which is caught in a shunt circuit by the aid of a second commutator, which only comes into action when the first commutator goes out.

When this motor is supplied by a continuous current, it is easy to understand that the induced current which passes through the shunt circuit, and which is caused by the demagnetisation, is proportional to the mass of iron and wire of which the machine is composed, or proportional to its inductive capacity. This current is purely a secondary effect, of short duration, and only occurs once at each break of the commutator.

The motor is of such a size, that when supplied with a continuous current of proper strength the induced electrical effect in the shunt circuit will light one incandescent lamp. If, however, it is supplied with an alternating current of the same power, it will light eight lamps, and the mechanical power given off is even more than with a continuous current, provided that the alternations from the dynamo do not exceed 6,000 a minute.

At first I was considerably puzzled by this great difference, because in both cases it is impossible for the lamp circuit to be acted upon by the main current. It occurred to me, however, that the rapid alternations of the exciting current from the dynamo, and the consequent speed of magnetic molecular rotation, gave the latter a certain momentum, and that by widening the insulating strips of the first, or main current commutator, and proportionately increasing the width of conducting surface in the shunt commutator up to certain limits, this effect would be increased. I found such to be the case, from which I inferred that the increase of induced current in the shunt circuit was on account of its longer duration, by reason of the acquired momentum of the magnetic molecular rotations *after* the alternating exciting current had ceased.

Those who have facilities for carrying out experiments may prove it in the following manner :—E, in the enclosed drawing, is an electro-magnet whose brushes press on two metallic bands, B and B^1, fixed to, but insulated from the spindle, A. The band, B, is in electrical circuit with the shunt commutator, S, and the main commutator, M ; whilst the band, B^1, is in contact with shunt commutator S^1, and main commutator M^1. This contact is made by conducting rods as indicated. The commutators, as regards their brushes, are so arranged that when M and M^1 are in action, S and S^1 are out of action, and *vice versâ*. The spindle and commutators are rotated by the pulley P. L is an incandescent lamp in the shunt circuit.



Let us now suppose the apparatus at rest, and the brushes in electrical contact with the main commutators M and M^1. The current from an alternating dynamo passes into the magnet, E, and rapidly reverses its polarity. By actuating the pulley, P, the commutators are rotated, when M and M^1 go out of, and the shunt commutators S and S^1 come into action, enabling the *after* current set up in the magnet to light the lamp, L, in the shunt circuit.

In order to make comparative tests, the same apparatus may be supplied with continuous instead of alternating currents. The after current in the former case, however, is much smaller, consisting of one electrical impulse only at each break of the commutator, whereas in the alternating system these impulses are practically continued ; the result being that, all things being equal, a far greater number of lamps may be used in the shunt than when supplied by continuous current only, and it would appear that this difference can only be attributed to the fact that the rotatory motion of magnetic molecules, or polarity of the magnet, E, acquires momentum when acted upon by a suitable physical cause such as alternating currents of electricity ; this momentum lasting a sensible time after the cessation of the acting cause.

If we had the gift of magnetic sight, and could see what is going on in the electro-magnet when it is excited by alternating currents, we should probably see the molecules or polarities tumbling over each other at an enormous rate. I do not think, however, that we should see anything but a vibratory motion as regards the iron molecules.

Telegraphy in Madras.—The new combined post and telegraph office at Madras, a handsome building, erected at a cost of six or seven lakhs of rupees, has been opened to the public.

A NEW FORM OF SPRING FOR ELECTRIC AND OTHER MEASURING INSTRUMENTS.*

By Profs. W. E. AYRTON, F.R.S., and JOHN PERRY, M.E.

(*Continued from page* 465.)

Under these circumstances, $2\,a$ being the major diameter, and $2\,b$ the minor diameter of the ellipse,

$$\phi = \frac{2\,l\,\mathrm{F}\,r \sin 2\,a}{\pi\,a\,b^3}\left(\frac{1}{4\,\mathrm{N}} - \frac{1}{\mathrm{E}}\right) \qquad (13),$$

f the maximum stress at a section

$$= \frac{2\,\mathrm{F}\,r}{\pi\,a\,b^2}\,(1 + \sin a) \qquad (14),$$

and

$$d = \frac{l\,\mathrm{F}\,r^2}{\pi\,a\,b^3}\left(\frac{\cos^2 a}{\mathrm{N}} + \frac{4 \sin^2 a}{\mathrm{E}}\right) \qquad (15).$$

Springs with a Rectangular Section.—For practical purposes it is obviously more convenient to use in the construction of our springs thin strips of a rectangular section rather than of an elliptic section. We have, therefore, now to consider how equations 13, 14, and 15 will be modified if our strip has a rectangular section, the longer side of the section being $2a$ and the shorter side $2b$. In this case

$$\mathrm{B} = \tfrac{4}{3}\,a\,b^3\,\mathrm{E},$$

and since, as was discovered by M. Cauchy in 1829, the torsion rigidity of a rectangle bears to the torsional rigidity of an inscribed ellipse the proportion of their moments of inertia about a line drawn through the common centre perpendicular to their plane, in the case when one principal dimension is several times the other, it follows that

$$\mathrm{A} = \mathrm{N}\,\pi \frac{a^3\,b^3}{a^2 + b^2} \times \frac{\frac{4}{3}\,a\,b^3}{\frac{\pi}{4}\,a\,b^3},$$

or

$$\mathrm{A} = \tfrac{16}{3}\,\mathrm{N}\,\frac{a^3\,b^3}{a^2 + b^2}.$$

Hence

$$\phi = \frac{l\,\mathrm{F}\,r \sin a \cos a}{4\,a\,b^3}\left(\frac{3}{4\,\mathrm{N}}\,\frac{a^2 + b^2}{a^2} - \frac{3}{\mathrm{E}}\right),$$

$$d = \frac{l\,\mathrm{F}\,r^2}{4\,a\,b^3}\left(\frac{3}{4\,\mathrm{N}}\,\frac{a^2 + b^2}{a^2}\cos^2 a + \frac{3}{\mathrm{E}}\sin^2 a\right);$$

or, as b^2 is insignificant in comparison with a^2,

$$\phi = \frac{3\,l\,\mathrm{F}\,r \sin a \cos a}{4\,a\,b^3}\left(\frac{1}{4\,\mathrm{N}} - \frac{1}{\mathrm{E}}\right) \qquad (16),$$

$$d = \frac{3\,l\,\mathrm{F}\,r^2}{4\,a\,b^3}\left(\frac{\cos^2 a}{4\,\mathrm{N}} + \frac{\sin^2 a}{\mathrm{E}}\right) \qquad (17).$$

We will now calculate the value of f, the maximum stress at any point in the rectangular section.

The shear stress at any point, $x\,y$, in such a section of the prism which has received a twist, τ, per unit of length is, where the axes of x and y are parallel to the edges of the section, and the origin the centre of the section, z being at right angles to the section,

$$\mathrm{N}\left(\tau x + \frac{d\,\gamma}{d\,y}\right) \text{ in the directions of } y \text{ and } z,$$

and

$$\mathrm{N}\left(-\,\tau y + \frac{d\,\gamma}{d\,x}\right) \text{ in the directions of } z \text{ and } x,$$

where γ equals $-\,\tau\,x\,y$ + an expression which vanishes if the thickness of the strip is very small.

Hence since

$$\frac{d\,\gamma}{d\,y} = -\,\tau\,x,$$

and

$$\frac{d\,\gamma}{d\,x} = -\,\tau\,y,$$

it follows that the shear stress at a point, $x\,y$, is

0 in the direction of y,

and

$-\,2\,\mathrm{N}\,\tau\,y$ in the direction of x,

so that the whole shear stress at a point is $-\,2\,\mathrm{N}\,\tau\,y$, and the shear stress, q, at the middle of the longer edge of the rectangular section, where we may suppose the shear stress is the greatest, is $2\,\mathrm{N}\,\tau\,b$.

Now if C is the twisting couple, we know that

$$\tau = \frac{\mathrm{C}}{\mathrm{A}},$$

hence

$$\tau = \frac{3\,\mathrm{F}\,r \cos a}{16\,\mathrm{N}\,a^3\,b^3}\,(a^2 + b^2),$$

and

$$q = \frac{3\,\mathrm{F}\,r \cos a}{8\,a^3\,b^2}\,(a^2 + b^2).$$

Also, since $\mathrm{F}\,r \sin a$ is the bending couple, the greatest stress due to bending,

$$p = \tfrac{3}{4}\,\frac{\mathrm{F}\,r \sin a}{a\,b^2}.$$

Hence if f is the greatest total stress anywhere in a section, it may be shown that

$$f = \tfrac{3}{8}\,\frac{\mathrm{F}\,r}{a\,b^2}\left\{\sin a + \sqrt{1 + \frac{b^2}{a^2}\cos^2 a\left(\frac{b^2}{a^2} + 2\right)}\right\}.$$

Or, as a is very large in comparison with b,

$$f = \tfrac{3}{8}\,\frac{\mathrm{F}\,r}{a\,b^2}\,(1 + \sin a) \qquad (18).$$

If, as is usual in the case of the springs we employ, the edges of the strip nearly touch one another in two consecutive coils, and the angle of the spiral is 45°, we have the area of the cylinder which the metal strip approximately covers, or $\frac{2\,\pi\,r\,l}{\sqrt{2}}$, equal to the area of the strip, or $2\,l\,a$, so that

$$\frac{r}{a} = \frac{\sqrt{2}}{\pi}$$

and equations (16), (17), and (18) may be simplified thus—

$$\phi \propto 0{\cdot}17\,\frac{l\,\mathrm{F}}{b^3}\left(\frac{1}{4\,\mathrm{N}} - \frac{1}{\mathrm{E}}\right) \qquad (19).$$

$$d \propto 0{\cdot}17\,\frac{l\,\mathrm{F}\,r}{b^3}\left(\frac{1}{4\,\mathrm{N}} + \frac{1}{\mathrm{E}}\right) \qquad (20).$$

$$f \propto 0{\cdot}29\,\frac{\mathrm{F}}{b^2} \qquad (21).$$

We have preferred to say that ϕ, d, and f are respectively proportional rather than equal to the expressions on the right hand side, because when the strip is wide in comparison with the radius of the cylinder about which it is bent, the strip receives in addition to the bending and shear strains which we have considered, a lateral bending also, and the exact effect of this we have not yet fully investigated.

Use of Spring to determine $\frac{\mathrm{E}}{\mathrm{N}}$.—Before proceeding to a description of the various measuring instruments in which we have applied this new form of spring, we may mention one interesting application of it to enable us to determine readily the ratio of the modulus of rigidity, N, to Young's modulus of elasticity, E, for any material. It is well known that the celebrated conclusion of MM. Navier and Poisson from Boscovich's molecular theory requires that the ratio of E to N should be 2·5 for all solids. Prof. Stokes showed that this conclusion was impossible if its authors supposed it to apply to jellies and to India rubber, and that it was probably untrue in the case of metals; and Wertheim, Kirchhoff, Thomson, Everett, and others have experimentally shown its untruth in the case of brass, iron, copper, and glass. In pursuance of the present investigation it has struck us that this ratio may be most conveniently determined by the use of our springs from one experiment.

When the spring is made of round wire, so that a and b are equal to one another, we have from equation (11)

$$\frac{r\,\phi}{d} = \tan a\,\frac{\frac{\mathrm{E}}{\mathrm{N}} - 2}{\frac{\mathrm{E}}{\mathrm{N}} + 2\tan^2 a};$$

let $\frac{r\,\phi}{d}$ be called $\cot \beta$, then it can be shown that

$$\frac{\mathrm{E}}{\mathrm{N}} = -\,2 \tan a \tan (a + \beta),$$

so that if a is 45°

$$\frac{\mathrm{E}}{\mathrm{N}} = \frac{\tan \beta + 1}{\tan \beta - 1} \qquad (22).$$

In order to measure $\tan \beta$ most conveniently, we may employ (fig. 6) a pair of cylindric scales, the distance apart of which, close to the wire of the spring, is a inches. A point, P, on the wire is observed in its position in the upper scale, the reading being b. Now the spring is elongated by an axial force until the point, P, comes opposite a point on the lower scale, and the reading is now c. As the two scales are similar and parallel to one another, and as a spirit-level has been employed to make the scales horizontal, it is obvious that as the axis is vertical

$$\frac{a}{c - b} = \frac{d}{r\,\phi} = \tan \beta,$$

so that

$$\frac{\mathrm{E}}{\mathrm{N}} = 2\,\frac{a + (c - b)}{a - (c - b)}.$$

We have used three springs made from round wire respectively of brass, iron, and steel for the sake of illustration. In all of

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* From the proceedings of the Royal Society, No. 230, 1884.

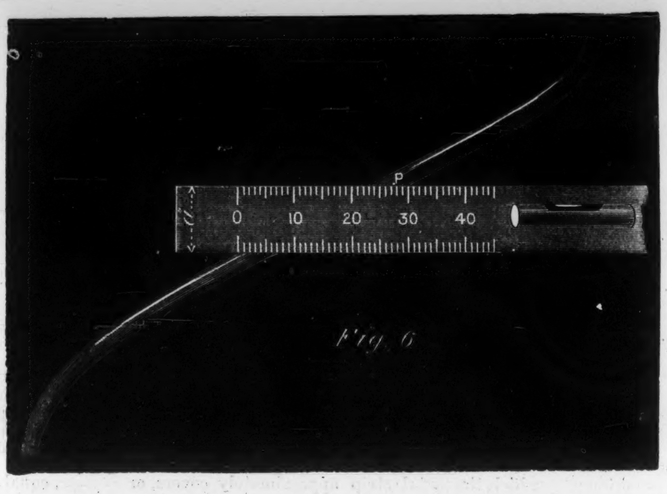

Fig. 6.

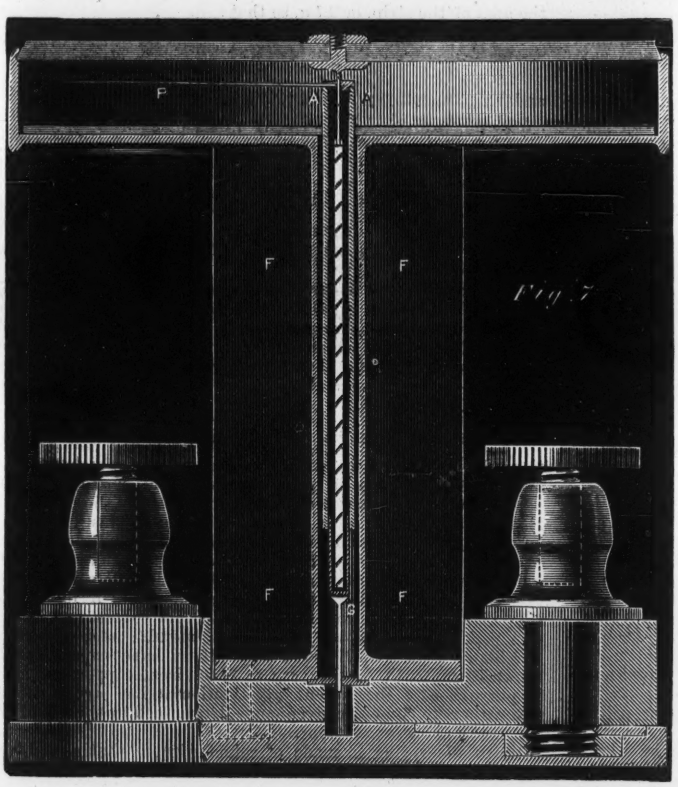

Fig. 7.

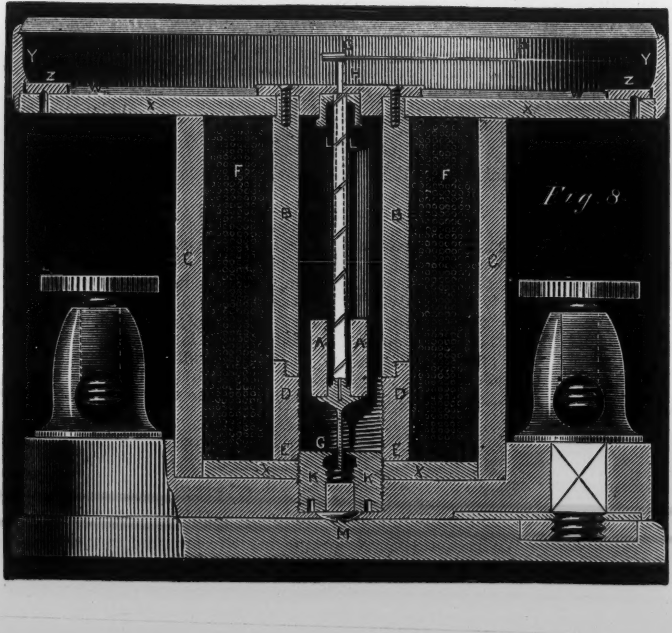

Fig. 8.

them we find that $c - b$ is small in comparison with a, so that roughly we may say that the excess of $\frac{E}{N}$ over 2 is $\frac{4(c-b)}{a}$, that is, is proportional to $(c - b)$. The cylindric scale has only been introduced for the sake of illustration. For an accurate determination of $\frac{E}{N}$, a telescope would be employed having a motion about the axis of the spring, and also a motion parallel to the axis, and by means of which the motion of a point on centre line of the wire when an axial force is employed, would be accurately observed. It is sufficient to say that the brass spring of round wire exhibited to the Society gives a value of $\frac{E}{N}$ which is 8 per cent. less than the value given by the similar spring of round iron wire exhibited.

Instead of using a round wire, we may use for the experimental determination of $\frac{E}{N}$ a strip of rectangular section, whose breadth is very great in comparison with its thickness. If the angle of the spiral is 45°, then from equations (16) and (17) it follows that

$$\frac{\phi r}{d} = \frac{\frac{1}{4N} - \frac{1}{E}}{\frac{1}{4N} + \frac{1}{E}},$$

$$\frac{E}{N} = 4\,\frac{d + \phi r}{d - \phi r};$$

therefore measuring ϕr as $c - b$, and d as a, by the method just described, we have

$$\frac{E}{N} = 4\,\frac{a + (c - b)}{a - (c - b)}.$$

Some Practical Uses of the Springs.—By the employment of springs such as we have described, we have succeeded in making *ammeters* and *voltmeters*, or instruments for measuring respectively electric currents and differences of potential, in which the pointer moves over in some cases as much as 270° of the scale instead of only 50°, which is all that can be obtained with ordinary galvanometers. One form of the instrument is shown in fig. 7, where A A is a thin hollow tube of charcoal iron attached at its lower end to a brass piece, G, guided at the bottom in the way shown. To G is attached the lower end of a spring made in the way we have described of silver or hard phosphor-bronze, the upper end of which is attached rigidly by a thin rod to the glass top of the instrument which itself is fastened rigidly to the framework of the instrument. The rod attached to the glass, and to which the upper end of the spring is attached, also serves as a guide to the top of the iron tube. In the space, F F, a solenoid wire or strip is wound, its ends being attached to the terminals shown. Hence when a current is passed through the wire, the iron tube is sucked into the solenoid, and its lower end, G, to which the spring is attached, receives a large rotatory motion, which is communicated directly to the pointer attached to the top of the iron tube. Parallax in taking readings of the pointer is avoided by the horizontal scale being on looking-glass in the well-known way.

By making the iron tube, A A, very thin, so that it is magnetically saturated for a comparatively weak current, by fixing it so that it projects into the solenoid a fixed distance which has been carefully determined by experiment, and by constructing the spring in conformity with the conditions worked out in this paper, so as to obtain a large rotation with minimum stress, and with not too much axial motion of the free end of the spring, we have succeeded in obtaining deflections up to 270° directly proportional to the current, and without any permanent set being given to the spring.

To prevent a spring taking a permanent set for a large deflection, it is of great importance that the spring after being delivered by the maker should receive a large degree of permanent set in the direction in which we wish it to be afterwards strained in ordinary working.

In spite of the fact that Prof. J. Thomson in the *Cambridge and Dublin Math. Journ.*, November, 1848, explained the importance of initial strains in materials, the reason is not yet sufficiently well understood why when a round bar has been well twisted beyond the limit of permanent set in a certain direction it has twice as much elastic strength to resist torsion in this direction as in the opposite direction. Now, in the very act of manufacturing our springs, that is in the bending of the strip, the material acquires strains which are just opposite in character to the initial strains which we wish it to possess, for, as already explained, if the spring be constructed as in fig. 3 an extension of the spring produces a rotation tending to uncoil it. Hence a spring must not be regarded as ready for use until it receives a good set by means of a weight hung from its end.

The instrument above described is "direct reading," that is one division of the scale corresponds with one division of the thing to be measured, and its sensibility is initially adjusted, partly by the amount of wire or strip wound on the bobbin, and partly by means of a small movable coil, the proper position for which is determined in each case experimentally by the makers, and there it is permanently fixed.

Theory of the Solenoid Spring Ammeter or Voltmeter.—If C is the current in ampères flowing through the coil, the attractive force on the iron core is

$$\frac{K C^2}{1 + S C},$$

where S is a constant, which is the greater as the current is smaller for which the iron tube, A A, fig. 7, becomes saturated with magnetism. The position of this iron core in the solenoid is so selected that K remains practically constant throughout the small range of downward motion of the core.

Since the rotation, ϕ, has been produced by an axial force, we know from the theory of the spring already given, that this axial force is $p\,\phi$, where p is some constant. Hence

$$p\,\phi = \frac{K C^2}{1 + S C},$$

and since $S\,C$ is great in comparison with unity for such currents as we wish to measure, we have

$$\frac{p\,\phi}{K} = \frac{C}{S} - \frac{1}{S^2},$$

or

$$C = \frac{S\,p}{K}\phi + \frac{1}{S},$$

that is, equal divisions of the scale correspond with equal additions to the strength of the current except close to the zero, and we usually do not graduate these instruments within 5° of the zero.

Shielded Measuring Instruments.—When it is desired to use the instrument close to a dynamo machine or electro-motor in action, we have adopted a different and somewhat special form of construction, which is shown in fig. 8, by means of which the instrument is to a great extent shielded from even powerful external magnetic fields. In this instrument the electro-magnet consists of a hollow core, part of which, B B, is of charcoal iron, and part, D E, of brass or other non-magnetic metal. The outside tube, C C, and the plates, X X, top and bottom, are also of charcoal iron. The space, F F, is filled with insulated wire or strip in electrical connection with the terminal, so that when a current is sent through the instrument an intense magnetic field is formed between D and E, which are the poles of the electro-magnet. To the iron tube, A A, also made of charcoal iron, the spiral spring, in this case made of extremely thin hard steel, is attached, the other end being attached to the piece, F, which is fixed relatively to the bobbin. The spindle, G G, which is fixed to the moving iron core, A A, moves freely in bearings, H H, so that the only movements of which A is capable are one of rotation and one parallel to the axis of the bobbin. As the iron core, A, projects into the strong magnetic field between D and E it is strongly attracted towards E when the current flows, and, as before, causes a large rotation of the pointer, P, over the scale. As a means of varying the power of the instrument an adjustable iron piece, K, is provided, which can be screwed nearer to or farther from the core, A, and by the use of which the sensibility of the instrument can be adjusted so as to make the instrument "direct reading," that is to say, each division of the scale can be made to correspond with 1 ampère of current, or 1 volt difference of potential, and the employment of a constant such as 1·34 ampères, or volts, per degree, which has hitherto been necessary with our measuring instruments, is now avoided. This power of adjustment produced by the use of the movable iron piece, K, combined with the ease with which more or less wire can be wound on to the instrument, which also constitutes a second adjustment of sensibility, is of considerable importance, since the employment of a constant has not only led to error and delay in measurements made in electric light factories, but has caused the breakage of the pointer or the destruction of an instrument from a far too powerful current being sent through it by an observer (often a man with little experience in the employment of instruments) having confounded the constant of some other instrument with that of the one he was using.

These magnifying spring instruments in their earliest forms only indicated the magnitude of the current, or the potential difference in ampères or volts respectively, and not the direction of the current. In our latest instruments, however, we have added a small compass needle, which indicates the *direction* of the current, while the principal pointer, as before, indicates the *magnitude* of the thing to be measured.

The steel strip used in the construction of the spring for these shielded instruments is 0·0017 inch thick, and in a book just published on "Steel and Iron," by Mr. Greenwood, he mentions that some specimens of remarkably thin steel, $\frac{1}{770}$ of an inch, were shown in the Paris Exhibition, so that steel we are using is nearly as thin as that referred to by Mr. Greenwood. But within the last few days we have received from Mr. Charles Jowitt, of Sheffield, a specimen of steel rolled for us only just over 0·001 inch in thickness, which is perhaps the thinnest steel yet made.

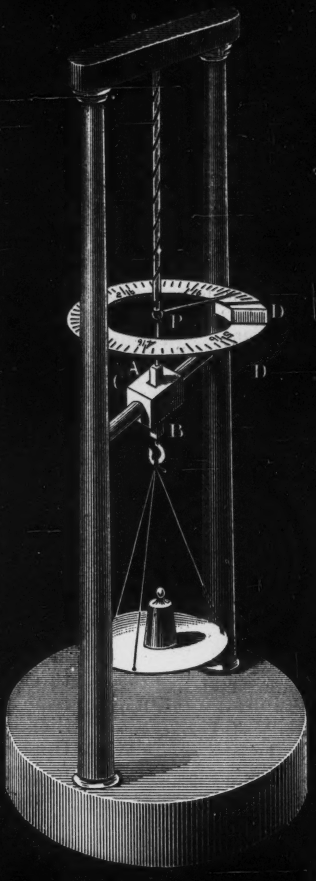

Fig. 9

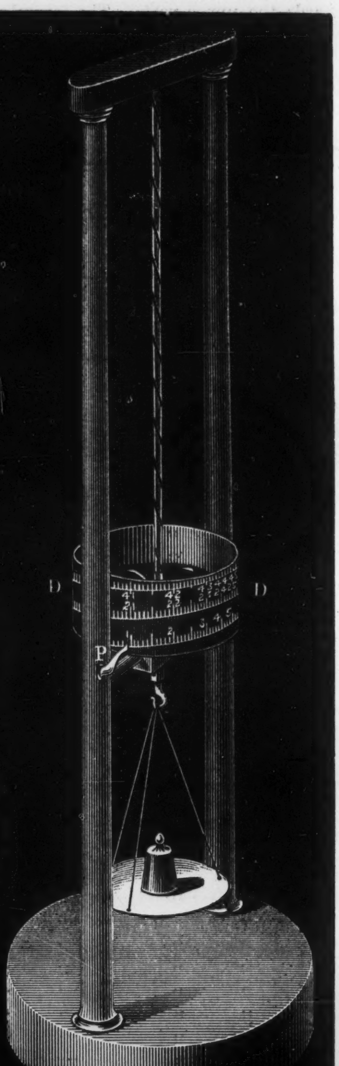

Fig. 10

We have to thank one of our assistants, Mr. Bower, for so earnestly carrying out a long series of experiments on these very delicate springs.

Weighing Machines.—Another class of instruments in which we have practically employed this spring are weighing machines, and fig. 9 shows one of the arrangements we adopt. The scale-pan is prevented from turning by the part, A B, being square and fitting very loosely a square hole in C. This arrangement introduces practically no friction, and prevents the moment of inertia of the scale-pan and load interfering, by means of a rotatory motion, with the rapidity with which the pointer comes to rest when a load is put into the pan. The position of the pointer, P, which revolves when a weight is placed in the scale pan, is read off upon the spiral scale, D, which, in this specimen, we have graduated in pounds. In another of these weighing machines, shown in fig. 10, the arrangement is the same with the exception that a cylindric scale, D, is fixed to the end of the spring and turns with it, the pointer P, fixed on the frame of the instrument points to an indication of the weight on a spiral line drawn on the cylinder, D. This second arrangement allows us to employ springs whose ends have a relative motion of five or six revolutions.

We have also made certain weighing machines where the weight is placed on a pan resting on the top of a rod passing up through the spring, and attached to the bottom of the spring, but hitherto we have found that this arrangement introduces too much friction.

When a very long spring is required for any purpose, and where the weight of the spring itself would cause greater stresses on the upper part than on the lower part of the spring, it is our custom to let the breadth and thickness of the strip of material remain unaltered, but to let the diameter of the coils diminish towards the upper parts. The formulæ already given suffice to show how this may be done so as to obtain uniformity of maximum stress at all sections.

We also present before the Society a model showing a combination of bifilar and spiral spring suspension, in which great rotation and small axial lengthening and shortening are produced by an axial force.

ON THE CONNECTION BETWEEN STRENGTH OF LIGHT AND DURATION IN GLOW LAMPS.

THE following table gives the results of prolonged experiments with Mr. Edison's lamps.

A 16 candle lamp burns, with a luminous power of

10 normal candles	5,550 hours.
11 ” ”	3,963 ”
12 ” ”	2,857 ”
13 ” ”	2,134 ”
14 ” ”	1,628 ”
15 ” ”	1,292 ”
16 ” ”	1,000 ”
17 ” ”	802 ”
18 ” ”	651 ”
19 ” ”	534 ”
20 ” ”	443 ”
21 ” ”	371 ”
22 ” ”	312 ”
23 ” ”	266 ”
24 ” ”	228 ”
25 ” ”	196 ”
30 ” ”	163 ”

A 10-candle lamp burns with a luminous power of

8 normal candles	2,260 hours.
9 ” ”	1,470 ”
10 ” ”	1,000 ”
11 ” ”	714 ”
12 ” ”	512 ”
13 ” ”	385 ”
14 ” ”	294 ”
15 ” ”	233 ”
16 ” ”	179 ”
17 ” ”	145 ”
18 ” ”	118 ”
19 ” ”	96 ”
20 ” ”	80 ”

It is therefore a merely relative notion if we speak of the time a lamp will last without knowing the luminous power and the tension which it has for the time.

Most private installations for electric lighting exist in factories and other commercial and industrial establishments where an engine employed in the business often serves to drive the dynamos. Even where there is a separate engine it is supplied with steam from the ordinary boilers of the works. In a paper mill, sulphuric acid works, &c., the pressure of steam may vary by half or even a whole atmosphere, according to the consumption, and the consequence is that the motor engine varies in the speed of its revolutions. With the changes thus produced the tension and the strength of the current in the dynamo must vary, so that differences of 20 volts may easily arise, affecting, of course, the light of the lamps.

How such changes affect the duration of the lamps is clearly seen from the above table.

I have often pointed out that the public should become accustomed to regard electricity as a something real, though imponderable. But all in vain. Steam-pipes are carefully packed with non-conducting materials in order to protect them from loss of heat, and like all other pipes they are tightly jointed to prevent leakage. Boilers and reservoirs of all kinds are fitted with manometers to show the pressure; but electricity has been, and still remains, something marvellous, with which any kind of folly can be carried on.

Why is not here also a manometer employed, a tension indicator—of which there is no lack—just to show how the machine works?

An example may prove the importance of such an apparatus. About a year ago the author put up installations for the incandescence light in two neighbouring establishments—a paper works and a mill. Both installations were on the same principles, of the same materials, and the same dynamos from the same maker. Both installations were fitted with voltmeters (Alppenboin's patent) and with Edison's B lamps. A difference existed only in the steam engines and the way they were attended to. The mill had an ordinary old one-cylinder engine, not running very regularly, whilst the paper works had a new three-cylinder engine, which gives an exceedingly steady light. But however well the latter engine works, it is only seen to at intervals by the night watchman of the works, while the machinery at the mill is under the constant inspection of the engineer of the working engine. He has always the voltmeter before his eyes, a wire resistance at hand, and keeps up a constant difference of potential of 98 volts.

The consequence of this different treatment is that the mill has completed 2,800 hours of actual burning with half its lamps at 50 volts each, whilst in the paper works all the lamps have had to be renewed, though they came into use some weeks later than those in the mill.

An Edison lamp is exhausted in about seven hours, and receives at the last moment a current of 200 volts in order to expel the last residue of air from the carbon threads. The method of manufacture, however, seems not to be the only factor affecting the duration of the lamps; the material and the preparation of the carbon threads are also of importance. The author knows from experience that the Swan lamps and those of Siemens Brothers last a long time. In a factory in Upper Silesia, which has made use of the glow lamps for two seasons, the average duration of the Swan lamps is 900 hours; one lasted 4,001 hours. Among the Siemens lamps in another establishment many lasted from 1,700 to 2,000 hours. Experiments with Müller lamps gave less favourable results, but the circumstances were abnormal, so that they cannot be quoted.—J. ZACHARIAS, *Zeitschrift für Elektrotechnik.*

LALANDE AND CHAPERON'S OXIDE OF COPPER BATTERIES.

IN order to practically realise the various models of the oxide of copper battery,* the principle of which we made known in 1881, we were obliged to pursue, state MM. Lalande and Chaperon in *L'Electricien*, a rather extensive series of researches, the results of which may be interesting. These researches, made during several months, have been lately, for special reasons, conducted chiefly by one of us, to whom is intrusted the determination of the practical conditions for employment and the construction of models of the new battery.

M. le Dr. A. d'Arsonval has kindly lent us his valuable assistance in this work. He has studied more especially the best form to be given to the battery for obtaining large power, and for rendering it applicable to electro-motors. We have preserved the dimensions of one of these models (a trough model), which has become the typical form. M. d'Arsonval has already published the principal results of his experiments, which were undertaken for purely scientific purposes. We must thank him, not only for the disinterested studies which he has devoted to our apparatus, but also for the favourable influence which his attention and advice have exerted upon the results of our researches.

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* See ELECTRICAL REVIEW for July 28th and August 11th, 1883.

Our object was to construct a voltaic element of long duration, but the conditions to be fulfilled, in order to obtain such a couple, are in fact very difficult to combine. In the first place, nothing must be consumed except on closed circuit; this eliminates all combinations with two liquids, in which the mixture of the solutions, retarded or not by porous diaphragms, necessitates an unproductive expenditure, which results in a low power (as in the case of the Daniell and the Callaud batteries), or a short duration of action (as in the case of the Bunsen battery). The combination sought must, therefore, have a solid depolariser.

The consumable metal must, moreover, not react upon the liquid in which it is immersed when the battery is not working. In examining the series of metals, which are of sufficiently low price for commercial employment, and that of electrolytes which attack them, we found that very few were suitable. This number is still further diminished if we require a strong chemical action between the metal and the liquid when the circuit is closed. There remained then only zinc in salts of ammonia, or very well amalgamated zinc in acids, which appeared capable of fulfilling these conditions. But the salts of ammonia can only dissolve a very small quantity of zinc before producing insoluble crystals, which cover the metal; and, as for amalgamated zinc, it is very notably dissolved in weak acids, which causes a considerable loss.

Fortunately there is another combination which answers the purpose, this is that of zinc and a concentrated alkaline solution. Described upon various occasions in special treatises, it was again brought before the attention of specialists at the time when we commenced these researches by various publications, among others those relating to the Reynier battery. Caustic potash or soda in solution at 30 or 35 per cent., for example, possesses the remarkable properties of not attacking zinc (or tin, lead, and some other metals), on open circuit, of possessing a very low resistance, and, lastly, of dissolving, when the battery is in action, considerable quantities of metal without producing any crystallisation or any objectionable deposit.

We hoped, therefore, by combining zinc and an alkaline solution with an efficacious solid depolariser to obtain the conditions of an element capable of action for a very long period, like the Leclanché battery, and furnishing, with small volume, constant currents of considerable intensity—several ampères, for example.

This naturally led us to try, as the depolarising material, metallic oxides, a large number of which are insoluble in the alkalies. Amongst all those which we have examined none seemed to furnish electrodes so suitable as oxide of copper.

DETAILS OF CONSTRUCTION.

Having ascertained in a general manner that the association of the properties of oxide of copper and those of alkaline solutions produced a couple of long duration with great power, we endeavoured to give it simple and suitable forms for various requirements.

The employment of solid depolarisers under the form of agglomerates has become very popular lately, and we first of all sought to give the oxide of copper this form. We have succeeded in obtaining a product possessing powerful depolarising properties, and resisting very well the dissolving action of caustic alkalies; we prepared it by mixing with the oxide of copper a small quantity of oxychloride of magnesium and grinding the material upon a metallic support to ensure contact. This method of employing the oxide enables us to easily form elements of small size and with great surface; however, it must be observed that, under the usual conditions, when the battery is not to be recharged after exhaustion, these agglomerate plates become, as in the Leclanché battery, a useless residue, and the work employed in their manufacture is entirely lost. On the contrary, the pure metallic copper resulting from the reduction of the uncombined oxide is far from being valueless. It consequently seemed to us more practical to apply the oxide upon the conducting support which, in this case, must be horizontal, by the sole action of its weight. We have already described various models constructed under these conditions, in which the depolariser rests upon a plate, or better at the bottom of a metallic vessel. This is the most suitable form for very numerous applications; the employment of agglomerates should be reserved for special cases.

In these elements the zinc is placed at the upper part, and during working, the very dense solution of zincate of potash which is produced falls to the bottom of the vessel, where it forms a sirupy layer, so that the zinc is immersed until the end in the non-saturated alkaline liquid which will attack it. The consumption is, under these conditions, perfectly regular, whilst plates of zinc dipping to the bottom of batteries of the same kind are consumed gradually more and more from the bottom to the surface. A plate of zinc three millimetres in thickness, placed horizontally, may be consumed so regularly as to have at the finish an uniform thickness of only two to three tenths of a millimetre. With batteries kept stationary, the separation of the solution of potash and the saturated solution of zincate which falls to the bottom may be sufficiently perfect to allow of renewing the exciting liquid by drawing off the saturated part and replacing it.

Soda gives sensibly the same results as potash, both as regards electromotive force and internal resistance. We generally employ potash, as we have already pointed out, to avoid the formation of creeping salts. However, this inconvenience may be avoided in large elements by simply covering the surface with a layer of a liquid which does not mix with soda.

It is advantageous to use rather concentrated solutions, at 30 or 40 per cent., for example. In fact, the solution containing 5 to 6 per cent. of potash dissolves very little oxide of zinc, and a solution of alkaline zincate precipitates from the oxide of zinc when we increase the water. There is therefore a proportion of unutilised alkali, the greater as the solution is less concentrated.

When the alkaline solution is concentrated, the consumption of the zinc continues, nevertheless, in closed circuit; but then the oxide of zinc is deposited as much at the bottom of the vessel as upon the zinc, which it covers with a rather hard crust; the appearance of these deposits indicates the exhaustion of the battery.

The carbonic acid contained in the air is absorbed by the potash of the batteries, especially if the surface is neither protected by a cover nor by a layer of liquid. This absorption, which is very slow, causes no other inconvenience than the waste of the quantity of potash passed into the form of carbonate. When the alkaline solution is saturated with oxide of zinc, and remains exposed long enough to the action of the air, it deposits crystals insoluble in water, which appear to be oxide or hydrate of zinc.

A rather serious inconvenience exists in nearly all batteries intended to remain mounted for a long time; this is that the zinc, even in open circuit, is consumed rather rapidly at the surface of the liquid, and for a short distance below the surface. It may thus be completely cut even when it has a considerable thickness, and the action of the element be arrested. The use of insulating varnishes or protecting tubes of India-rubber does not overcome this difficulty. If we suspend the zinc by a wire or a rod of another metal which is not soluble, we form a local couple which rapidly destroys the electrode at the point of attachment. We have thought, with M. d'Arsonval, of employing as the support of the zinc a rod or a plate of amalgamated brass or copper; amalgamated zinc does not form a couple with amalgamated brass, even after prolonged immersion. This simple method is of very great practical importance; we have adopted it for all batteries of great duration. The zinc is always completely immersed, and suspended by a conductor of amalgamated brass joined to the terminal.

According to the uses for which they are intended, oxide of copper batteries may be given various forms. Besides the models which we have described already, we have devised others, with an external vessel of cast iron, which presents the advantage of being hermetically closed, very easily transportable, and possessing great strength, which is a most important characteristic for elements containing a caustic liquid.

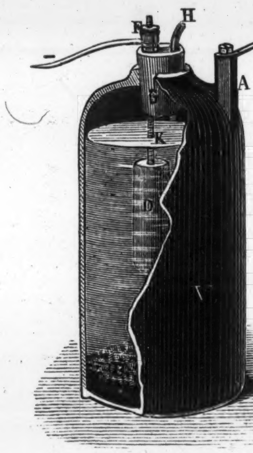

FIG. 1.

In one of these models (fig. 1) the external vessel is 0·09 m. in diameter, and constitutes the positive pole of the element; a projection, A, serves for attaching the conducting strip, C, for making connections. The exterior of the vessel is coated with paraffin, so as to render it unoxidisable, and to prevent leakage. The zinc, D, consists of a cylinder 0·02 m. in diameter, united to a rod of amalgamated brass, K, fixed to a stopper of India rubber G, and bearing the terminal F. The stopper is pierced by a metallic tube, terminated by a safety valve, H, formed of a split India rubber tube.

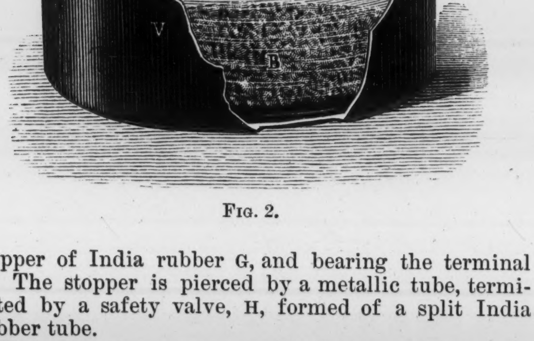

FIG. 2.

These elements are generally delivered filled with the solution of potash, so that to start them it needs only a suitable quantity of oxide of copper which will sink to the bottom at B, and to then close the element by means of the India rubber stopper supporting the zinc.

This arrangement is specially suited for indoor service (telephones, bells, &c). A smaller model, 5 centimetres in diameter, is amply sufficient for a service of several years for indoor bell-work.

Fig. 2 represents another type of an hermetically sealed element more recently introduced. It has great surface (0·22 m. in diameter), and may be used for the same purposes as Bunsen, bichromate, &c., batteries; charging accumulators, domestic lighting, electro-plating, induction coils, spectrum analysis, &c. The arrangement of this element is very similar to that of the preceding. The oxide of copper, B, is placed upon the bottom of the vessel; the zinc, D, formed of a long sheet coiled in the form of a spiral in order to present a large surface, is suspended from a cover of ebonite, G, fixed over the aperture of the vessel by means of a ring of iron and three screws; an India rubber washer ensures a perfect joint.

These large elements contain the same charge as our large trough elements (2 kilogrammes of potash and 0·900 kilogrammes of oxide of copper), and may replace them for all purposes. They can produce considerable work. For instance, a battery of trough elements can supply an Edison 5-candle lamp for more than 200 hours. By employing six elements, we were able during nearly two months to do nickel-plating for 7 hours per day, which had formerly necessitated the employment of three Bunsen elements. These had to be recharged every two days, and were far from giving as constant a current, which caused numerous difficulties.

These cast iron models possess the remarkable property of giving without polarisation a more considerable power than corresponding non-metallic elements, of which the conducting surface in contact with the oxide of copper would be as great. As hydrogen is not disengaged upon the cast iron, it seems to us that its great surface should nevertheless be charged with nascent hydrogen, which is transported progressively to the oxide of copper, and thus continuously assists the depolarising action.

It remains for us to determine the practical arrangements for reversible batteries of small and of great power. When an oxide of copper battery is exhausted, and we pass a current through it in the right direction, the oxygen which is carried to the positive pole is absorbed integrally by the reduced copper; but if the support of the depolariser is of copper, this is dissolved in small quantities, colouring the liquid blue. However, the copper resulting from the reduction of the oxide is not dissolved at all. We are aware that, in employing as a support a surface of iron or cast iron, we avoid the consumption and solution of copper, provided that the oxide employed had been free originally from metallic copper. The serious difficulty is the depositing of the zinc; this metal is precipitated in a form which is not sufficiently coherent; especially when we wish to obtain at all a great thickness. We avoid this inconvenience, either by precipitating the zinc upon a very large surface of amalgamated brass or copper, for instance, upon a mass of copper shavings, or by precipitating it upon a horizontal surface of amalgamated brass, covered with an excess of mercury, and provided with cavities in which the metal may lodge. The lower part of this support is covered by an insulating coating. The zinc can then only deposit upon the surface, and as it is immediately amalgamated, the deposit becomes coherent, and may be used without loss to give a fresh supply of electricity in dissolving.

We hope to be able to make known shortly definite models of reversible batteries constructed according to these data.

The Mackay-Bennett Cable.—The steamer *Faraday* on Monday night completed paying out 840 miles of cable, this quantity being all that was on board. The end was buoyed, and the vessel then started for England.

SECONDARY BATTERIES—AN IMPORTANT DECISION.

JUDGMENT was recently given in Washington, U.S.A., after a three years' legal struggle, in favour of Mr. Swan as against Mr. Brush, concerning the priority of invention of the perforation of plates for secondary batteries. We may mention that Mr. Swan's invention, here and abroad, is the property of the Electrical Power Storage Company.

The invention in controversy is as follows:—

"A perforated or cellular plate for secondary batteries having perforations or cells extending through the plate and the active material or the material to become active packed in said perforations or cells substantially as described."

In June, 1881, Brush filed a series of applications for improvements in secondary batteries including the case "I" in interference. This application relates primarily to electrodes, or plates having an active coating of metallic lead mechanically applied.

Plain, corrugated, and ribbed plates were the only examples of the application of the invention shown and described in the specification and drawings, and the claims as originally filed appear to have been limited specifically to these or equivalent forms of the invention. The specification, however, contained a general statement that the described method was particularly applicable to the plates shown in cases B and C.

In case B were shown and described various kinds of corrugated plates, and in case C various kinds of ribbed plates, including perforated plates. The various cross references in these applications were deemed objectionable by the examiner, and the applicant was required to so amend the applications that each should be complete in itself. Accordingly, June 1st, 1882, the applicant filed an amendment, introducing into this case "I" another sheet of drawings showing perforated plates like those shown in case C, the perforations being packed with porous material.

The interference was originally declared under the title of Swan *v.* Brush, Brush being given the filing date of his original application. This action was based upon the theory that although case "I," as originally filed, did not show or describe the perforated plate packed with porous material, the invention was inferentially included therein by the reference to case C. The interference was decided upon the record in favour of Brush by the Examiner of Interferences, no testimony having been submitted by either party. Upon appeal the Examiners-in-Chief reversed this decision, holding that the invention was not included in Brush's application until June, 1882, when he filed the amendment and supplementary drawings, showing and describing specifically the perforated plates. Upon appeal to the Commissioner this decision of the Board was reversed, the Commissioner ruling that Brush was entitled to a record date as of the date of his original application. Upon rehearing, however, it was held by the Commissioner that while the papers in case "I," as originally filed, might give authority for the admission of the amendment of June, 1882, the filing of the amendment must give the record date of the invention so introduced into the application under the ruling in the case of *ex parte* Snyder, 22, O. G., 1975. The language of the decision is:—

"It is evident that Brush's application clearly illustrating and describing the invention was not filed until the figure illustrating that form of invention had been added to the drawings, and a full description had been introduced into the specification. With this understanding of the case, and in the absence of all other testimony, Swan, having been the first to file his complete application within the meaning of rule 38, must be deemed the prior inventor."

Upon a further motion to rehear and set aside this decision, the Commissioner declined to depart from the position before taken that Brush's application was not complete before the filing of the amendment in June, 1882. Upon the representation, however, of Brush, that he would be able to show that he in fact made the invention thus introduced into his application before the record date of Swan, all the decisions in the case were set aside, and the case was remanded to the Examiner of Interferences for the purpose of allowing the parties to take testimony in support of their respective claims, the burden of proof in this new proceeding being placed upon Brush. Brush has introduced in evidence the series of applications to which reference has been made, and has also introduced testimony in support of his claim.

So far as his claim to priority of invention rests upon the disclosure furnished by the applications in question, it may now be regarded as definitely settled by the decision of the Commissioner that these applications did not of themselves, as originally filed, and without further explanation, distinctly disclose the invention in controversy. There was not in the range of these applications, as originally filed, a drawing showing a perforated plate packed with porous material, nor was there in all the specifications any distinct description of such invention. The specification in case "I" referred generally to the various forms of plates shown in cases B and C as suitable for being packed with porous material according to a method therein described; but in illustrating the proposed invention, the applicant selected from the variety of plates shown in these cases the corrugated and the ribbed or honeycombed plates, thus limiting by these specific examples the more general language of the description.

This interference does not involve broadly the mechanical application of porous material to electrodes or plates, but a special improvement in the form of plates so treated. It would be a mere inference to conclude that Brush at the time he filed this application had distinctly contemplated the invention in controversy. As the burden of proof in this case rests upon Brush to show by undoubted evidence that he made this invention prior to the filing date of Swan, it is necessary to resolve any reasonable doubt, such as naturally arises under the circumstances named, in favour of Swan.

The testimony offered by Brush fails to remove the doubt which arises upon the face of the papers. Brush does not state specifically that he at any time invented the subject-matter in controversy. He states that he made drawings showing the invention on or about May 1st, 1881. This allegation, however, must be understood in connection with the facts and circumstances as developed in the testimony. He states that he prepared the original applications, and understood that the cross references in the various applications were equivalent to introducing into each case all that had been described in the other cases. In all this, however, there is no positive statement that he ever contemplated as a matter of fact the treatment of the perforated plate in the manner described. In his own testimony he does not detail the history of his invention further than is involved in the preparation of the applications. He testifies that at least a month before the applications were filed he made pencil drawings for the draughtsmen to copy in preparing the applications, adding that several of these drawings fully illustrated the subject matter involved in this controversy. These drawings are not produced in evidence, nor are they described. It appears, however, that they correspond substantially with the drawings originally filed with the specifications, as it is agreed that the drawings were prepared from these sketches. As has been seen, however, the drawings as originally filed did not contain any figure showing a perforated plate packed with porous material.

Brush testifies, it is true, that the drawings filed in cases C, D, and E were copied directly from these sketches. The drawings, however, in cases C and D do not show the invention in controversy. Case E, which has since become patent 274,082, does show perforated sheets packed with porous material. It appears, however, from the record of the case that these drawings were filed as an amendment in June, 1882, and it was admitted by counsel at the hearing that they were made in Washington in June, 1882. It is clear, therefore, that these particular figures were not prepared from the sketches, or at least there is no competent evidence that they were so prepared. It is not shown that the sketches were preserved, or that they were forwarded to Washington. The testimony of Engel on this point must be regarded as a mistake, and as given under a misapprehension of the facts of the case. I fail to see that the testimony advances Brush's case beyond the point before reached. It does not appear that at the time the applications were filed he had made any drawings showing the invention, or that he had disclosed to any one, in conversation or otherwise, the fact that he had made such an invention. The drawings themselves do not even suggest the invention, and there is no evidence that Brush did anything else in connection with this invention except to prepare the applications in question, which, as originally filed, fail upon examination to distinctly describe the invention.

In the meantime Brush must be charged with a knowledge of the art as disclosed by Swan's British patent 2,272, of 1881, which was published in this country in the fall of 1881. This patent disclosed to the public full information of the invention in controversy, and it was not until the following year, and presumably after he had become informed of the invention therein contained, that Brush filed the amendment of June, 1882, for the first time illustrating and describing a perforated plate packed with porous material. To overcome the force of the prior publication of the invention it is necessary for Brush to show beyond a reasonable doubt that he had, before the date of the patent, perfected and used the invention, or that, having conceived of the invention before that time, he was using all reasonable diligence in adapting and perfecting the same. The proof of a prior invention to anticipate a prior completed invention or a patent or a printed publication should undoubtedly be clear and positive both as to the fact of the invention and its reputed date. The only evidence offered in support of his invention to sustain the burden of proof thus placed upon him is the record of these applications and prior sketches alleged to have been made; the prior sketches, however, are not introduced in evidence. The whole case of Brush is an inference from the remark in case "I" that the method therein described was applicable to the plates shown in cases B and C; that he, in fact, proposed to treat the perforated plates shown in case C by the method in case "I." The force of this inference is very much weakened by the absence of any positive testimony by Brush while on the stand to the effect that he had made such an invention. At the time the testimony was taken the counsel were well aware of the position of Brush's case. The re-opening of the case was upon the express understanding that Brush would introduce positive testimony to show that he had made the invention in controversy at least as early as the time of his application. Even if it be presumed that the idea in fact suggested itself to Brush that the perforated plate of case C might be subjected to the treatment described in case "I," it is clear that he did not attach any importance to that suggestion, and certainly did not consider it of sufficient significance to specifically illustrate or describe it in the applications which he filed. In this view the suggestion would appear to be a mere random conception which was never followed up or esteemed of any particular value, which left no traces in actual performance, and whose very existence at the time is problematical. I must conclude, from a careful review of the whole case, that Brush has failed to sustain the burden of proof, or, in the language of the Commissioner, "has failed to show that he made the invention prior to the filing of Swan's application." Swan is therefore adjudged the prior inventor.

Limit of appeal, twenty days.

FRANK MACARTHUR,
Examiner of Interferences.

BOOKS RECEIVED.

A Practical Treatise on Electric Lighting. By J. E. H. GORDON, B.A. London: Sampson Low, Marston, Searle & Rivington, 188, Fleet Street, E.C.

Electricity: its Theory, Sources, and Application. By J. T. SPRAGUE. Second edition, greatly enlarged. London: E. & F. N. Spon, 16, Charing Cross.

A Handbook of Electrical Testing. By H. R. KEMPE. Third edition. London: E. & F. N. Spon, 16, Charing Cross.

NOTES.

Electric Lighting.—News has just been received that the contract has been let for lighting, by electricity, the magnificent Parliament Houses in Melbourne. The contract has been given to the Australian Electric Light Company, with whom the Australasian Company has recently amalgamated its Victorian interests. The installation will provide dynamo power for 1,350 lamps, but probably only 1,000 will be needed at one time. In connection with this, the Australasian Company has ordered "Victoria" dynamos from the Anglo-American Brush Company. The lamps to be used are those of Swan.

The Australian Company has likewise secured the lighting of the General Post Office at Melbourne, which is an important sign of the progress now being made in electric lighting in Australia, where many public buildings are now fitted with this light only. A very fine display has just been made at the Victorian Inter-Colonial Exhibition, which has been lighted solely by electricity. A similar arrangement on a smaller scale was made at the recent Exhibition at Christchurch, in New Zealand, where during the whole period the building was entirely dependent on the electric light.

About 300 of the rebels attacked Suakin on the night of the 28th ult., but were frightened away by the electric light, the firing of the guns of the *Albacore* and of the guns and rifles in the forts.

In a letter to the *St. James's Magazine*, of August, 1879, Mr. Charles Lever, of Bowdon, Cheshire, detailed an account of a visit just previously paid by him to Mr. Edison's laboratories at Menlo Park, and his remarks respecting Edison's system of electric lighting will no doubt be found interesting to our readers at the present moment:—"Around the interior of the large machine shop, and bracketted from the walls, are Mr. Edison's new electric lamps, containing his platinum and iridium burners, encircled in transparent globes about the size of an orange, the burners themselves being not more than an inch long, and spiral in form. The lights from the burners are found to be clear, steady, and soft, and each light is equal to 30 or 40-candle power. These lights are worked by a small 'Gramme' machine, and the current is equally subdivided into these lamps, about 24 in number. The cost of working is very trifling, as the motive power has not to be specially provided in this case. It has been said that iridium is a rare and costly metal, and the same has been said of platinum, but Mr. Batchelor informed me that burners composed of these metals, indestructible under 50-candle power, are now being made in immense numbers at a less cost than 20 cents (10d.) each."

Commenting upon the lighting of Chesterfield, *The Sheffield Daily Telegraph* says:—Happy Chesterfield, where all her sons are men of light and leading! At this moment the City of the Puzzling Spire enjoys the distinction of being probably the best lighted town in England. A new contract has been entered into with the Gas Company, and that with the Electric Lighting Company has not quite expired, so that for a few nights the streets are being illuminated with both gas and electricity. The Gas Company, spurred to noble deeds by electric competition, have set up some very powerful lamps in the market-place and other open spaces, and these, with the "arc" lamps previously there, make the places brilliancy itself. In the smaller streets a gas lamp and an electric "incandescent" are burning sweetly and sociably side by side.

An electric light installation has been completed at the Park Pit Ocean Collieries, South Wales. A 6-horse power Marshall engine, fitted with Hartnell's patent automatic expansion gear, drives a Crompton-Bürgin self-regulating dynamo. Fifty 20-candle power Swan incandescent lamps are distributed underground and on the surface over the screens, workshops, and engine houses.

The steamship *Royal Dane*, one of the fleet of steamers owned by the Tyne Steam Shipping Company, has been fitted up with the electric light, and if the new mode of illumination is found to be satisfactory, as it is confidently expected, it is likely that all the passenger steamers of the company will be fitted up in the same manner. The illuminating power is derived from one of Siemens' dynamo machines placed in the engine-room, which is driven by a 4-horse power Tangye engine, supplied with steam from either the main boilers or the donkey-engine boiler. Lights of 20-candle power each are fixed in the saloon, sleeping-berths, and other places; and in the engine-room and stoke-rooms the lamps can be moved about. A switch-board is placed near the dynamo machine, by means of which the lights can be turned on or off, each light being independent of the others. The machine is driven by rope gearing in groove pulleys, and a sliding bed is provided for the machine, so that the gearing may be tightened whenever necessary. In addition to the lamps in the cabins, &c., two large portable lamps, each containing six lights equal to 300-candle power per portable lamp, are provided for lighting the holds, so that the work of loading or unloading may be carried on safely at night time. These lamps can be moved about to any part of the deck, and when suspended from the rigging light up not only the holds, but also any small craft lying alongside or at the wharf. There are altogether 43 lights on board the vessel, and the fitting-up has been done by Messrs. J. H. Holmes and Co., electric light engineers, Westgate Road, Newcastle. The *Royal Dane* is the first vessel trading from the Tyne which has been fitted up with the electric light, and the experiment will no doubt be watched with much interest by the owners and agents of all the large passenger steamers trading from this port.

The Montreal Board of Fire Underwriters are taking steps to have all the electric light wires in Montreal properly insulated, and to have an inspector for that purpose appointed by the City Corporation.

The Citizen Electric Illuminating Company of Brooklyn has after long delays, states the *New York Electrical Review*, been authorized by the City Government to run its wires, and will at once put in 100 Thomson-Houston arc lights.

Electric lights are coming into use for steamboats on the Mississippi.

It is stated that the electric lights on the high masts at Los Angelos, Cal., can be distinctly seen from the Island of San Clemento, 80 miles out at sea.

The Boston Post Office was wired and fitted with the Edison light early in the winter, but it was not put into operation till quite recently. It works perfectly, and is a great boon to the clerks, who have had to work in an atmosphere heated and vitiated by gas.

The Police Board of Greenock is pursuing inquiries with a view to fulfilling the conditions of the Electric Lighting Provisional Order. The Electric Lighting Committee of the Board reported to the last meeting of that body that a proposed experiment should be made, involving the use of 100 incandescence lamps of 20-candle power each. Mr. Mavor, electrical engineer, Glasgow, had reported to them what plant in his opinion was necessary for lighting the district selected; and Mr. Samuel Stewart, the manager of the gas works, had submitted a report which showed that the gross cost of the plant would be £1,435. The current would be obtained from a dynamo machine capable of working 100 such lights, itself to be driven by a turbine of 25 horse-power, laid down at the Prospect Hill filters. The Committee reported in favour of using the Kinetic Engineering Company's conducting mains of sufficient size for the whole district.

Messrs. Woodhouse and Rawson recently made application to the police authorities at Glasgow for permission to carry wires overhead, or in tubes underneath the causeway, for the purpose of supplying electric light to certain firms in several of the leading thoroughfares in that city. The matter was remitted for consideration to several members of the Town Council and the Master of Works, who, in their report on the subject, stated that they did not consider that it would be advisable to grant liberty to lift the causeway of the public streets for any such purpose.

It is reported that Mr. Edison is about to introduce a new "arc" system. It is hard, says the New York *Electrical Review*, to reconcile this with what Mr. Edison has said in the past about the arc light, but it may be true. If so, of course he will carry his wires underground. It will be remembered that he has said over and over again that arc light wires ought to go underground, and that there was no good reason why they should not be put there.

In the report of M. de Lesseps to the Suez Canal shareholders, stress was laid on the introduction of the electric light, which will enable the passage of vessels to go on by night as easily as is now the case by day.

An installation has been fitted up, and is now in full operation, at the mansion of Mr. C. P. Huntington, Astley Bank, near Darwen. The engine-house has been erected by Mr. James Pilkington at the rear of the mansion, in which stands one of Otto and Crossley's gas engines, of 3½ horse-power, which drives one of the "Victoria" B^2 compound dynamos, also fixed in the engine-house, within a few yards of the engine. "Victoria" 60 volt incandescent lamps are used, and the lights are fixed on the existing gas lamps and chandeliers. Three electric lights are to take the place of six gas jets. The following is the number of lights:—Drive 4, hall 4, verandahs 6, drawing-room 15, dining-room 4, reception-room 5, billiard-room 13, study 1, sitting-room 4, nursery 6, housemaid's pantry 1, engine-house 2, bedrooms 13, landings 8. The lights are so arranged that in every case each light can be turned on and switched out separately. In Mr. Huntington's bedroom there is a little button, and by pressing his finger upon it he turns a valve belonging to the gas engine, and in this way stops the engine. So far the lighting has been carried out without the slightest hitch arising. The whole of the work has been carried out by Mr. F. D'A. Goold, electrical engineer, Manchester.

The New York *Electrical World* states that the Brooklyn Board of Aldermen have rescinded a resolution passed a week ago giving two electric light companies the privilege to erect poles and wires in the eastern and western districts of the city. The resolution was rescinded at the suggestion of Mayor Low, and the same general privileges have been accorded the companies in another resolution, which, however, contains terms much more advantageous to the city. Each company is to furnish free to the city four lights, each of 2,000 candle-power, and one light free for every 30 furnished to private consumers. Lights furnished to the city shall be charged for at the rate not to exceed 70 cents a night for those of 2,000 candle-power, and not to exceed 15 cents per light for those of 16-candle-power. The companies also bind themselves to furnish 2,000 candle-power lights to private consumers at a price not exceeding 75 cents a light and 15 cents for 16 candle lights.

Telephonic.—The telephone box at the office of Mr. Walter Kavanagh, Fire Insurance Agent, Montreal, was entirely destroyed by fire recently, the result of a cross connection with an electric light wire.

The Russian authorities have recently placed telephones in all their public offices, and in the principal fortresses throughout the country.

The subscribers to the Hamburg Telephone Exchange have been much exercised by a communication received from the Postal Telegraph Department at Berlin, in which they are informed that the amount of subscription is no longer to be fixed according to the direct distance of the aerial lines, but according to the distance actually traversed by the wires.

Telegraphic Items.—The only republic in South America without a telegraph is Ecuador.

The Government at Bogota has solicited a tender for the construction of about 500 miles of telegraph line from the town of Panama to Costa Rica, but has met with no response.

The Western Union Telegraph Company is circulating petitions among business men asking Congress not to interfere with the business of the telegraph companies.

The French Atlantic Cables.—The s.s. *Pouyer-Quertier* left Rouen, on the 28th ult., at two o'clock, direct for Saint-Pierre-Miquelon, in order to repair one of the cables of the Compagnie Française du Télégraphe de Paris à New York, in which a fault exists at about 300 miles from the coast of Saint-Pierre. Her crew consists of 63 men, under the command of Captain Stuart-Fossard, and she has also on board M. Ebel, the electrician, M. Collignon, the general secretary of the company, and a physician. The *Pouyer-Quertier* was built at Newcastle by Mitchell. She is of 1,200 tons burden, with a draught of 6.50 m., and specially fitted for laying and repairing cables. Since the laying of the French cable she has only had to make repairs three times, and she has been in dock for twenty-one months in the port at Havre. We learn that at the last general meeting of shareholders of the company, which took place on Monday in Paris, the accounts presented were passed unanimously, and a dividend of 20 fr. per share was voted. A reserve sum of 250,000 fr. was also placed to the reserve fund, bringing the total up to 600,000 fr. The meeting reported a sum of 250,000 fr. to the credit of the profit and loss account.

Telegrams for China.—The Great Northern Telegraph Company notifies that in addition to the well-known stations in China, several other towns in that country have lately been connected by Telegraph. The following is now a complete list of the different stations, with the rates attached:—To Hongkong, Shanghai, Foochow, Amoy, Gutzlaff, 8s. 4d. per word; Canton, Fattschan, Ngouchow, 8s. 9d.; Chinkiangpoo, Chinkiang, Chining, Kiukiang, Kiuning, Lanchee, Nankin, Ningpo, Nganken, Puching, Shiakwan, Soochow, Taku, Tientsin, Wuhu, 9s. 7d.; Hankow (telegrams addressed "Hankow" are until further notice sent by daily steamer from Kiukiang), 9s. 10d.; Tungchow, 10s.; Pekin (plus postage of 1s. 10d. from Tungchow, for each telegram), 10s. Telegrams are accepted at the Company's station, and at all postal telegraph stations, and should be marked "*viâ* Northern."

The Telegraph Extension to Barra.—The following letter has been sent to an Inverness gentleman :—

General Post-Office, London,
15*th May*, 1884.

Sir,—In reply to your letter of the 8th instant, I beg leave to inform you that this Department has been authorised to send the telegraph to Castlebay, Barra, and steps will be taken to carry out the extension when the cable ship of the Department, which is now engaged on other urgent work, is available.

I am, Sir, your obedient servant,
(Signed) C. H. B. PATEY.

A Portuguese American Cable.—A telegram from Madrid, dated June 2nd, says the concession granted for laying a cable from Portugal to America, *viâ* the Azores, has been transferred to a joint stock enterprise, entitled the American, British and Continental Cable Company, Limited, which, by Royal Order, has its legal *status* recognised in Portugal. The Portuguese journals add that the first section of the cable to St. Michael's is expected to be laid by September next.

The *Pall Mall Gazette*, alluding to the above telegram, says :—"The American, British, and Continental Company is, we believe, Mr. Alderman Hadley's offspring, and the concession said to have been transferred has long been in Mr. Hadley's hands, so that there is nothing very new in this telegraphic news from Madrid. Mr. Hadley's Company has not yet been floated, and when it will be seems very problematical. The concession to pick up at the Azores, however, is undoubtedly a valuable right for any Atlantic cable enterprise to be possessed of."

Cable Repairs.—The Secretary of the West India and Panama Telegraph Company, Limited, writes that the Key West Havana cable is now repaired, restoring communication *viâ* Cuba to all their West Indian stations.

Telegraphy in Brooklyn, N.Y.—An official report shows that there are 5,817 poles and 3,001 miles of wire used for telegraph and telephone purposes in the City of Brooklyn.

Telegraph Tariffs.—At the Society of Arts on Wednesday evening, May 21st, a paper on Telegraph Tariffs was read by Lieutenant-Colonel C. E. Webber, R.E., C.B. The chair was occupied by Dr. Cameron, M.P. In the course of his paper the lecturer said that the machinery of transmission might be classed as follows:—The offices, the *personnel*, the mechanical means, the porterage. At the earliest establishment of the electric telegraph every one connected with it seemed to have thought of no other classification of rates except that governed by distance. This was rational enough, as the administration of those early lines was largely in the hands of people who were connected with railway traffic who at once turned their attention to making each communication pay for itself. While there were comparatively few messages and any speed greater than that of a railway train was worth paying for, no better mode of charging could be suggested. All the means were expensive—the manipulation, the instruments, and the line—and no acceleration was attempted which increased their cost ; hence distance rates commended themselves at once. The ultimate objects upon which the success of the service depended—namely, the production of efficiency of service for the public, must all turn on the proper understanding and use of one co-efficient—namely, time. The measure of cost and of accuracy must be subordinate to the expenditure of time. In 1876 a paper by the lecturer was laid before Sir Lyon Playfair's Committee of the House of Commons suggestive of a scheme of "deferred" or "second-class" messages and descriptive of the means by which he proposed to bring it into force. The scheme claimed to tap a new source of revenue without materially diverting existing channels, and to utilise spare means with little change. It is designed to leave the 1s. message alone with its existing conditions and facilities, and that the Post Office should accept a new kind of *petite vitesse* messages and forward it under certain conditions for 6d. The message might be called "second-class" or "deferred," the main condition of transmission of the messages to be that no second-class was to be forwarded while a first-class message was on hand. The Postmaster-General objected to this plan on what he might call an eminently postal view of it. It was one of the oldest forms of answer employed by the Post Office to say that the public would not like any change, but he was too great a believer in the soundness of Mr. Fawcett's own teaching to believe that he really thought the public would object to two kinds of telegrams more than they objected to two classes of railway carriages or trains. Uniform rates possessed a fascination for some people, but what had become of uniform rates within the Post Office itself ? Was not its uniformity subject to the co-efficient of weight for letters and numbers of words for telegrams ? Why should not the time rate be tried in connection with the telegraph system ? Dr. Cameron, Mr. Matthew, Mr. Saunders, Mr. Graves, and other gentlemen, also addressed the meeting.

Female Telegraphists.—On Monday evening last week Mr. W. Redmond asked the Postmaster General whether a female telegraphist in the service previous to a rule, at present existing, "prohibiting her marrying and retaining her situation," might not marry without being called upon to resign ; and, if not, was she not entitled to compensation for a service of about 13 years. Mr. Fawcett said the rule had been in operation for many years ; it made no exception in favour of women who were in the service at the time it was established. All, whether appointed before or after the date of that rule, must resign on marriage, and on their resignation they were not legally entitled to either pension or gratuity in respect to the years they had served.

The Postmaster-General and the Telephone.—The *Western Morning News* of Saturday, May 24th, commenting upon the remarks made in the House of Commons recently by Mr. Fawcett respecting telephone licenses, says :—"So it is as a trustee, not for the Post Office but for the public, that the Postmaster-General taxes a new invention and nearly strangles an infant industry. It is as a trustee for the public that he imposes conditions which prevent the use of the telephone in other than large towns. It is as a trustee of the public that he limits the use of a wire, so that there shall be few subscribers at a high price instead of many subscribers at a low price. It is as a trustee of the public that he excludes the larger public from all the benefits of the new invention, and prohibits the establishment of the penny telelogue. For the sake of public revenue he abolishes the public convenience, and insists that people shall use the antiquated telegraph (if it be really antiquated) and pay a shilling per message, instead of using a method of communication cheaper, handier, and more satisfactory. The public is made to pay that the State may be paid. We venture to suggest to Mr. Fawcett that he totally misunderstands the reasons which led the public to put the telegraphs in the hands of Her Majesty's Government. The House of Commons, if ever the question is seriously raised, will not justify or support a policy which virtually suppresses the telephone that the telegraph may gain in the competition. If the telephone is a telegraph still the telephone patent is not free. The proper course, therefore, would be for Mr. Fawcett to make such terms with the telephone companies as would best serve not the interests of the Post Office, but the interests of the public. It is not wonderful that when Mr. Fawcett acts as a monopolist he acts with the unintelligence which always seems to accompany the possession of a monopoly. To his surprise he has not improved telegraphic revenue, but he has—he confesses it—checked the development of the telephone. Will he learn the truth ? The truth is, and

American experience has shown it, that there is no surer way of increasing the telegraphic revenue, than by developing telephonic enterprise. We hope that Mr. Fawcett will keep his promise; and that he will once more rise above officialism, and think less of Postal revenue and more of public convenience. If he will seek first the best means of communication, and its development, telegraphic revenue will be added unto him."

The Lancashire and Cheshire Telephone Company has been in correspondence with the Postmaster-General for the purpose of obtaining permission to extend its operations in order the more completely to meet the public requirements and convenience, and the *Manchester Courier* says it has met with scant courtesy and no encouragement. A proposal to join the Exchanges at Manchester and Oldham by a trunk wire, to throw open the communication between the two places exactly as if they formed parts of the same town, and to make no extra charge to their Exchange subscribers for the use of the trunk wire, has met with serious opposition. The adoption of the proposal would have been a great convenience to commercial men, but the Post Office authorities refused their sanction to it excepting upon terms which were practically prohibitory. In order to promote the public convenience, it was proposed by the Telephone Company to establish a call office service, an arrangement which would enable a non-subscriber to use the telephone, on a moderate payment, in order to speak to any subscriber on the system, but the Post Office imposed conditions which put a stop to the project. Private clubs became subscribers to the Telephone Company, and the Postmaster-General not only objected to the arrangement, but requested the company to remove their instruments at once. Believing that they had the right to fix instruments and wires for private use wherever they were called for, the company refused to comply with the request, whereupon pressure was brought to bear upon the clubs, and Mr. Chas. Moseley, the chairman of the company, in a statement of the case which he has prepared, states that the Post Office authorities "have inflicted so much terrorism in the minds of the members of the clubs that all of them have given up the use of telephones."

The Turin Exhibition.—Tuesday evening the 27th May was fixed for the inaugural ceremony of the electrical section at the Turin exhibition, and punctually at the appointed hour (nine) their Majesties the King and Queen of Italy, accompanied by Prince Amedeus (ex-king of Spain), the Duchess of Genoa, Prince Thomas, and many others of the royal family, entered the brilliantly lighted and gaily decorated gallery where they were received by the chief members of the exhibition committee; Professor Galileo Ferraris acting as *cicerone*. The first visit was made to the exhibit of the Eastern Telegraph Company, represented by the Chevalier Alfred Eggington. Their Majesties expressed themselves highly interested and much pleased at the working of Sir William Thomson's "Recorder," and announced their intention of returning to examine more minutely into the details of the instrument. His Majesty the King did not fail to inform himself as to the extensive network of the Eastern Company's cables, and repeatedly declared his admiration for such enormous undertakings. His Majesty, after having most graciously shaken hands with the officers of the Eastern Company, continued his tour round the dazzling gallery, after which the royal party crossed over to that portion of the building where the Edison and other systems of incandescence lamps lighted up brightly a dozen separate rooms richly furnished as *boudoirs*, dining-rooms, &c. The gardens of the exhibition showed up well under the electric light, and the thousands of visitors seemed thoroughly well satisfied with their evening's amusement.

House to House Electric Lighting.—Early this month the South-Eastern (Brush) Electric Light Company will give practical illustrations of house to house lighting at Colchester on the B.T.K. system of electrical distribution in combination with storage batteries. Under this system, which has already been described by us, electricity is supplied on similar lines to that of gas, a constant light being obtained without entire dependence upon the generating machinery, the electricity being stored in the company's stations. The system is stated to be very economical owing to the small size of the conductors employed, and the saving in engine and dynamo power. A high tension continuous current is used for charging the batteries, and by this means economical leads can be employed, and by the combined action of the master cell and rocking switches, the tension of the current supplied to the houses is limited to the potential of the lamps in use. To accomplish the above object the following works have been carried out, viz., a central station where a steam engine, constructed by Messrs. Davey, Paxman & Co., is employed to drive high tension "Brush" dynamo machines which supply current for charging accumulators in various parts of the district to be lighted. Accumulators are placed at the central station and in subsidiary stations situated in the High Street and Head Street. The cables communicating between the central and subsidiary stations, and between the latter and the houses, are laid in a brick trench beneath the pavement, occupying a very limited space. In order to reduce the potential in the houses to below the limit prescribed by the rules of the Board of Trade, rocking switches are employed which serve not only for this purpose, but also to maintain a constant supply of current to the houses. Contrivances also exist for preventing the overcharge of current in the batteries, and consequent injury to the plates.

Lighthouse Illuminants.—The *Times* of the 5th inst. has a lengthy article upon the experiments in lighthouse illumination now proceeding at the South Foreland lighthouses, to which we have previously alluded, and from it we extract the following interesting remarks:—"It is worthy of note that the South Foreland lighthouses, which were originally illuminated by means of coal fires, were the first in which electricity—carbon in a more refined and more highly intensified form—was adopted as an illuminant. This was in 1857, when Professor Holmes first submitted his system of lighthouse illumination by electricity to the Trinity House, and received permission to establish his apparatus in the high light, the system being afterwards extended to the low light. England was thus the first to adopt electricity for lighthouse illumination." At the conclusion of the article, the writer states that the preliminary photometric observations appear to indicate that the electric light in comparison with either the gas or the oil light is as the sun is to a candle.

Technical Education.—The report of the Royal Commission on Technical Education, which has just been issued, goes thoroughly into the results of the investigations made by the commissioners, who assert that England is not so far in the rear of other countries in this matter as many persons have supposed, some of our institutions having the object of an extension of practical teaching and scientific knowledge exciting the wonder and admiration of nations where technical schools have long been established.

American Institute of Electrical Engineers.—At a recent meeting of this newly-formed society a resolution was passed approving Senator Platt's Bill, providing for a patent office department, entirely distinct from overruling authority other than the Commissioner of Patents, and the influence of the members and associates of the institute was directed to be exerted to prevent any restriction of the rights and privileges of inventors as they now exist under the laws. The committee on organisation, having reported that they had completed a proposed set of rules for the government of the institute, the thanks of the meeting was tendered for the efficient manner in which they had discharged the duties entrusted to them.

That the society is a representative one will be seen by the list of officers elected, which is as follows:— President, Dr. Norvin Green; vice-presidents, A. G. Bell, C. T. Cross, T. A. Edison, G. A. Hamilton, C. H. Haskins, F. L. Pope; managers, C. F. Brush, W. H. Eckert, S. D. Field, E. Gray, E. J. Houston, C. L. Hillings, F. W. Jones, G. B. Prescott, W. W. Smith, W. P. Trowbridge, T. N. Vail, E. Weston; treasurer, R. R. Hazard; secretary, N. S. Keith.

The Expedition to Khartoum.—With the pontoon train already ordered for the proposed expedition to Khartoum will be forwarded a few torpedoes for river service, and the usual electric apparatus in connection therewith. A number of telegraph waggons fitted with reels for paying out and picking up wire, and accompanied by a line of considerable length, are also to be sent out, and are now in course of preparation at Woolwich.

Great Fire at Electric Light Works.—A Reuter's telegram of May 29th, states that a fire, which raged for some time with considerable violence, broke out on that day in the workshops of the Swan United Electric Light Company at Lille. The flames spread to several neighbouring houses. Four persons were more or less seriously injured by the falling in of a portion of the second floor of one of the burning buildings. The loss is very considerable.

South Kensington Mutual Electric Lighting and Supply Company, Limited.—Mr. Justice Kay, on Friday, the 30th ult., made the usual order for the compulsory winding up of this company on the petition of Mr. Burchell, a creditor.

Kelway's Electric Log Syndicate, Limited.—A petition for the winding up of this company has been presented to the Court by Edward Gilbert, of 187, Upper Thames Street, of the firm of George Smythe and Co., printers and stationers, a creditor; the petition is directed to be heard on the 13th inst.

St. George Telephone Company, Limited.—Mr. Justice Chitty has appointed George Boggis, of 14 and 15, St. Swithin's Lane, public accountant, to be official liquidator of this company.

Gülcher Electric Light and Power Company Limited and Reduced.—A petition to confirm the resolution reducing the capital of this Company from £300,000 to £150,000 has been presented to the Court.

Telpherage.—Professor Fleeming Jenkin, L.L.D., F.R.S., wishes it to be known that the model of the telpher railway can be seen in action at No. 18, Fitzroy Street, W., on Friday afternoons, by members of the Society of Arts and others, on presentation of their visiting cards.

NEW COMPANIES REGISTERED.

Bull's Continental Power Company, Limited.—Capital £1,000,000 in £1 shares. Objects: To manufacture on the Continent of Europe electrical appliances, gas, steam and other apparatus, engines, boilers, waggons, &c.; and to acquire certain Continental patents granted to Mr. Hy. Clay Bull. Signatories (who are all of Paris): R. D. Hessenbeuch, 20 shares; A. A. Goreau, 2 shares; F. A. Vautier, 1 share; L. Pillivagt, 1 share; A. Guyot de Dome, 1 share; N. H. V. Milbank, 20 shares; M. D'Aub, 1 share. Registered 28th inst. by Messrs. Beyfus and Beyfus, 69, Lincoln's Inn Fields.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Railway Electrical Contractors, Limited.—An agreement, dated 21st ult., and filed with the documents of this company on the 28th ult., provides for the allotment of 750 fully paid shares to Messrs. Wm. Stroudley and E. J. Houghton as part of the consideration for the assignment to the company of certain English and foreign letters patent.

Deal and Walmer Electric Light Company, Limited.—The registered offices of this company are now situate at 5, Clanwilliam Road, Victoria Town, Deal.

Dollond Electric Ships' Log Company, Limited.—An agreement, dated 2nd of January, filed on the 28th ult., provides for the purchase from Mr. Tysen Crawford, of the firm of Messrs. Dollond & Co., opticians, of certain British and foreign patents relating to the manufacture and construction of an electric ship's log. The purchase consideration is 1,200 fully paid shares of £5 each and £3,000 in cash. The vendor will also be entitled to a royalty of £5 per cent. on the retail selling price of any article manufactured according to such letters patent. The British patent is No. 3,128, dated 3rd July, 1882.

Hammond Electric Light and Power Supply Company, Limited.—The annual return of this company, made up to the 1st ult., was filed on the 28th ult. The nominal capital is £330,000 in 66,000 shares, of which 56,133 have been issued and the full amount has been called thereon. The calls paid amount to £279,580, leaving £1,085 unpaid. Since this return was made up the nominal capital has been increased by the addition of £195,000 in £1 10s. shares. As compared with the return for the year 1883, the paid-up capital shows an increase of £199,530.

CITY NOTES, REPORTS, MEETINGS, &c.

Kelway's Electric Log Syndicate, Limited.

An extraordinary general meeting of this company was held at the office, 58, Lombard Street, on the 22nd ult., Mr. Robert Heane presiding, at which the following resolutions were passed:—

"That it has been proved to the satisfaction of the syndicate that it cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and that the said Kelway's Electric Log Syndicate, Limited, be and is hereby wound up voluntarily.

"That Mr. Edwin James Morris, of 58, Lombard Street, in the City of London, chartered accountant, be and is hereby appointed liquidator of the syndicate."

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or 6 per cent. per annum, free of income-tax, for the quarter ending March 31st, and payable on the 24th of June. The books will be closed from the 16th to the 23rd of June, both days inclusive.

J. B. Rogers Electric Light and Power Company, Limited.—Mr. Justice Kay has appointed Mr. Frederick George Painter (of Messrs. Tribe, Clarke, Painter & Co., 2, Moorgate Street Buildings, E.C.) official liquidator of this company.

Electric Carbon Storage Company of Scotland, Limited.—Warrants have been issued for the payment of a first dividend of 5s. in the pound to the creditors of this company.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of May was 3,339, estimated to produce £2,950 against 3,848 messages, producing £3,376 in the corresponding month of last year. The receipts for the month of February, estimated at £3,000, realised £3,099.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 30th, were £2,632, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of May, 1884, are £1,562, against £1,641 in the corresponding period of last year.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending May 31st, 1884, £4,240.

NEW PATENTS—1884.

8328. "Regulating electric currents applicable for use with dynamo-electric machines supplying numerous incandescent lamps, &c." A. B. HOLMES, J. C. VAUDREY. Dated April 28.

8376. "Electric automatic fire alarms." A. C. BROWN. Dated May 29.

8400. "Controlling electrically the motion of steam or other engines." A. E. PORTE, E. MANVILLE. Dated May 30.

8443. "Electric arc lamps." C. LEVER. Dated May 30. (*Complete.*)

8447. "Bracket for incandescent electric lamp." W. E. H. SCHARINA. Dated May 30.

8448. "Electric switch." E. F. H. H. LAUCKERT. Dated May 30.

8460. "Mechanism for transporting goods and passengers by aid of electricity." F. JENKIN, A. C. ELLIOTT. Dated May 30.

8497. "Electrical accumulators." A. C. HENDERSON. (Communicated by J. J. Barrier, F. Tourvieille, and J. E. Legay.) Dated May 31.

8503. "Measurement of electrical conditions as to the electromotive force and quantity in ampères and volts." W. ROWBOTHAM. Dated May 31.

8504. "Measuring the resistance of conductors of electricity specially with reference to arc and incandescent lights, motors, and dynamos (differential electrical balance)." W. ROWBOTHAM. Dated May 31.

8524. "Telephonic transmitting instruments or valve telephones." S. P. THOMPSON, P. JOLIN. Dated June 3.

8528. "Insulators for electrical wires." E. L. SHELDON. Dated June 3.

8532. "Presses for moulding glass insulators." L. B. GRAY, J. HAM. Dated June 3. (*Complete.*)

8539. "Telephones." J. T. LISTER. Dated June 3.

8541. "Telegraphic and telephonic apparatus." D. SINCLAIR, J. L. CORBETT. Dated June 3.

8554. "Electric arc lamps." A. M. CLARK. (Communicated by Wirth & Co. [S. Schuckert]). Dated June 3.

8555. "Dynamo-electric generators." A. M. CLARK. (Communicated by Wirth & Co. [S. Schuckert]). Dated June 3.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

4295. "Signal indicator apparatus." H. BOTTEN. Dated September 6. 8d. This invention has for its object improvements in signal indicator apparatus, and is applicable more especially for engine room telegraphs, for steam ships, for railway carriages to indicate from station to station, for tramcars, lifts, offices, factories, also for railway trains, for signalling from passengers to guard, or from guard to guard, or to engine-driver, or for other such-like purposes.

4576. "Facilitating the electrical transmission of news, &c." G. L. ANDERS. Dated September 25. 2d. The present improvements are designed to facilitate the rapid dissemination of news and other information throughout a large town, or in any number of towns or stations. (*Void by reason of the patentee having neglected to file a specification in pursuance of the conditions of the Letters Patent.*)

4594. "Dynamo-electric machines." F. H. VARLEY, J. R. SHEARER, and R. H. PADBURY. Dated September 26. 6d. Has for its object the construction of dynamo machines based upon the discoveries of Faraday and Ampere, whereby a continuous current is developed in a conductor placed parallel to a central magnet so long as the conductor is rotated round the magnet.

4617. "Apparatus for generating, regulating, measuring, recording, and integrating electric currents." Sir W. THOMSON. Dated September 28. 3s. (This specification is too lengthy to enable an abstract to be made.)

4657. "Secondary voltaic batteries." H. F. JOEL. Dated October 1. 2d. Relates to methods of constructing and combining the electrode plates for secondary voltaic batteries, and to arrangements for regulating the action of those batteries when they are employed in connection with a producer of electricity, such as a dynamo-electric machine, and with objects such as electric lamps in which the electricity is applied. (*Provisional only.*)

4710. "Telephonic and telegraphic apparatus." A. R. SHAW. Dated October 3. 8d. Relates chiefly to telephonic apparatus and comprises a transmitting instrument and a receiving instrument. It also comprises a novel method of constituting an electrical circuit for use in connection with these instruments and otherwise.

4728. "Voltaic batteries." A. C. HENDERSON. (Communicated from abroad by N. Basset, of Paris.) Dated October 4. 6d. Consists in an economical method of constructing voltaic couples or elements yielding a primary, constant, and intense current, also in the formation of secondary elements for completing the work of the primary couples, and accumulating and storing the product of these elements.

4769. "Telegraph cables." T. C. LOE. Dated October 8. 2d. The core of the cable is constructed as at present, whether it be to contain a single insulated conductor or several, and it is also lapped or served with fibrous material in the usual way. Around this are laid a series of flat bands of galvanised iron or steel, or other protecting metal. These bands are thin, and of a breadth equal to several times the thickness. They are laid so as to abut the one on the other edge to edge, and so as to form a complete metallic sheathing. Over the sheathing the cable receives a serving of fibrous material. (*Provisional only.*)

4778. "Preventing or neutralising earth or foreign currents in electric telegraph wires. J. W. FLETCHER. Dated October 9. 6d. The object is to counteract or neutralise earth or foreign currents and prevent them from objectionably affecting the instruments or apparatus used with telegraph wires. For this purpose, the inventor introduces insulators in new positions in certain kinds of signalling appliances, and provides novel means and connections for neutralising any unexpected or other earth or foreign current.

4780. "Dynamo or magneto-electric generators." H. B. FORD. Dated October 9. 2d. Consists principally in balancing the force of attraction which each pole of a field-magnet or magnets exerts upon an armature while approaching such pole, by the force exerted against such magnetic attraction (in the same proportion) in compressing air, gas, vapour, or a spring of any kind, until the full, or end of the attraction is reached. (*Provisional only.*)

4781. "Conductors of electricity." J. G. PARKER. Dated October 9. 4d. My invention, says the inventor, is based on the principle that the electric current passes along the surface of the wire, or other conductor, and not through its substance; and further, that the insulating material with which it is usual and generally necessary to cover the surface of the conductor operates, by its contact with such surface, to impede and diminish the force of the electric current in its passage along such surface. The object of my invention, therefore, is to obviate, or minimise, the impediment or resistance thus encountered by an electric current in its passage along an insulated metallic conductor, and the loss of force resulting from such resistance, and at the same time to maximise the conducting surface of the conductor in proportion to its bulk!!!

4787. "Electrical synchronous telegraphic and other systems." SYDNEY PITT. (Communicated from abroad by P. B. Delaney, of America.) Dated October 9. 1s. Relates to apparatus described in the number of the REVIEW for February 2nd, 1884.

4800. "Electro-magnets." J. H. JOHNSON. (Communicated from E. F. Recordon, of Switzerland.) Dated October 9. 6d. Relates to improvements in electro-magnets whereby the mass of metal and length of wire required to produce a given effect is considerably reduced, and the electric current is more advantageously utilised than in ordinary electro-magnets.

4801. "Preparing plates or elements for use in secondary batteries." H. J. HADDAN. (Communicated from abroad by C. F. Brush, of America.) Dated October 9. 8d. Relates to certain improvements in the "forming," as it is technically termed, of electrodes, elements, or plates, for use in secondary batteries, and the nature of it consists chiefly, and in general terms, in a process or method of operation, wherein the lead plate, or other form of battery element, is alternately heated and cooled, after and during, or in the intervals of an electro-chemical charging action.

4815. "Electric arc lamps." H. W. PENDRED. Dated October 10. 2d. Relates to mechanism for automatically controlling the position of the carbons in arc lamps. (*Provisional only.*)

4835. "Magneto generators of electricity." M. BENSON. (Communicated from abroad by J. P. Stabler, of America.) Dated October 11. 6d. The object of the invention is to vary the strength of the current at will, without changing the speed of the armature, and without the interposition of resistance in the line current for that purpose.

4861. "Galvanising wires by galvano-plastic process." L. A. GROTH. (Communicated from abroad by E. Deutgen, of Germany.) Dated October 12. 2d. The wires pass through the metal bath over rollers and between anodes of nickel, or other suitable plating material, arranged on supports that can be raised or lowered in the bath, and which are connected with the battery in the usual manner. The wires pass through the bath without interruption in a continuous movement, the velocity of the motion and the draft and length of the vessel containing the metal bath being so arranged that the wire is sufficiently coated with metal while passing through the bath. (*Provisional only.*)

4875. "Electric arc lamps." W. H. AKESTER and R. MITCHELL. Dated October 13. 2d. Has for its object by improved mechanism to effect a gradual feeding or progressive movement of the carbon or carbons combined with an automatic device for making the carbons approach each other when separated so far as to interrupt the light. (*Provisional only.*)

4879. "Treating gold ores or other auriferous substances, and more especially rebellious or refractory gold ores and concentrates, by electrolysis without previously furnacing the same."

H. R. CASSEL. Dated October 13. 4d. In treating free gold ores or other auriferous substances by electrolysis a solution of chloride of sodium is advantageously used. The solution is decomposed by electrolytic action, and the nascent chlorine thus generated rapidly combines with the gold, and the chloride of gold formed is easily dissolved in the water of the solution. Of course any other salt in solution, capable of generating chlorine under electrolytical decomposition may also be employed. When, however, rebellious or refractory gold ores and concentrates (such as pyrites, for example) are treated with such a solution, a secondary action takes place and prevents the extraction of the gold contained in the ore. The reason of this is that the chlorine and hydrogen liberated combined and form hydrochloric acid, which attacks any compound of iron in the ore, and changes it into a proto salt, and this proto salt immediately precipitates the gold in solution as fast as it is formed. The presence of free hydrochloric acid is further objectionable as it also attacks any antimony, arsenic or other rebellious or refractory elements contained in the ore. The object of the invention is to prevent this, and for this purpose the inventor proposes to add to the ore to the solution a substance which will neutralise the hydrochloric acid as soon as it is formed, but which will not precipitate the gold. The substance it is proposed to employ is lime, but any suitable alkaline earth or other chemical compound or element for which the hydrochloric acid has a stronger affinity than for the compounds of iron in the ores, but which will not precipitate gold, may be employed.

4880. "Telephonic apparatus." G. L. ANDERS. Dated Oct. 13. 6d. Relates to telephonic receivers and to methods of connecting the same with the line, and with the batteries and other apparatus necessary for its effective operation. The improvements are designed to obviate the necessity heretofore experienced of using a permanent magnet as part of the receiving instrument in cases where the transmitting microphone is not connected in the main line circuit, but influences the latter through the medium of an induction coil, such permanent magnets being both heavy and costly.

4881. "Electrical belt." C. B. HARNESS. Dated October 13. 6d. Relates to apparatus for applying electricity for medical curative purposes and comprises an improved electrical belt adapted to be worn upon the person."

4885. "Dynamo-electric machines." C. H. BENTON. Dated October 13. 6d. Consists of improvements in dynamo-electric machines, by which the ratio of the actual magnetisation of the exciting magnets to the magnetic force of the magnetising helices is economically increased, and by which the field of force thus economically obtained is more completely utilised for the production of an electric current.

4898. "Coupling electric accumulators employed for the production of motive power for application to various purposes." A. C. HENDERSON. (Communicated from abroad by G. Philippart, of France.) Dated October 15. 2d. Relates to a novel method of regulating to a nicety the delivery of electric accumulators, and varying as desired the intensity of the current, and consequently the power produced. (*Provisional only.*)

4914. "Electric arc lamps." H. J. HADDAN. (Communicated from abroad by De. E. Boettcher, of Leipzig.) Dated October 16. 2d. Consists chiefly in utilising, for the regulation of the electric arc, that part only of the iron core of a solenoid which, while protruding from the coil, corresponds to an approximately uniform electro-magnetic attraction for a given strength of current. (*Provisional only.*)

4926. "Transmitting electrical impulses to a distance, especially applicable to Submarine Telegraphy." A. W. L. REDDIE. (Communicated from abroad by La Société Universelle d'électricité Tommasi of Paris.) Dated October 16. 8d. Relates to a novel construction and arrangement of induction relay for facilitating the transmission of electrical impulses to a distance, and is especially applicable to submarine telegraphy.

4945. "Conductors for electrical railways or tramways." A. SIEMENS and JOHN. W. BUDD, executors of W. SIEMENS. (The result partly of a communication made from abroad by Dr. E. W. Siemens, of Berlin.) Dated October 17. 6d. Relates to the conductors used for that mode of propelling vehicles by electricity, in which the electrical current is conveyed from an insulated conductor to an electro-dynamic machine on the vehicle by means of a contact truck or slide, which is drawn along the conductor by the vehicle.

4947. "Measuring electrical energy." A. SIEMENS, J. GORDON, and J. W. BUDD, executors of W. SIEMENS. (Communicated from abroad by Dr. E. W. Siemens, of Berlin.) Dated October 17. 6d. According to the present invention a ring forming the polar extension of an electro-magnet, and consequently having the magnetism of the pole uniformly distributed throughout its mass, has mounted loose upon it one or more coils or bobbins through the wires of which the current to be measured is made to pass. This coil or bobbin is thus made to travel with uniform force round the ring in a certain direction. If the magnetism of the magnet and ring is sufficiently below the maximum of magnetisation, it will always be proportional to the strength of current in the coils of the electro-magnet, and the force which tends to move the coil or bobbin along the ring will therefore be proportional to the product of the strengths of the currents in the coils of the electro-magnet, and in the moving bobbins.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Letters, &c., for the "Correspondence" columns should arrive not later than Tuesday morning if they are desired to appear in the following number, such communications to be addressed to the "Editors," ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

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CORRESPONDENCE.

Telephone Patents.

Mr. Handford's very clear reply omits one point that I think may cause misapprehension on the part of some of your readers as to what constitutes infringement of a patent. He says, without qualification, that the putting together of the parts of a patented telephone would suffice to constitute an infringement. This cannot be true without the very important limitation that the instrument so put together is used for the purposes for which the instrument has been described by the patentee as being intended to be used. For example, it cannot by any kind of logic be shown to be an infringement of a patent granted for a telephone invented for transmitting vocal or other sounds, to put together an identical instrument as a galvanometer to detect currents in a Wheatstone's bridge, or as a detector of leakages on lines. I think Mr. Handford would himself entirely agree in such a qualification. If I invent a new kind of coalscuttle, and patent the combination of its parts, *quâ* coalscuttle, surely there is nothing except the dread that I may threaten with law-suits to prevent any other person from using a precisely similar combination of identical parts, say, as a cradle or as a helmet. He does not infringe my patent unless he uses the combination as a coalscuttle. I might, perhaps, bully him into thinking so by sending solicitors' letters to him; that is if I forgot myself so far as to do so.

Silvanus P. Thompson.

University College,
Bristol, *May* 31*st*, 1884.

[We would once again remind correspondents that we do not insert anonymous contributions.—EDS. ELEC. REV.]

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[illegible] Paternoster Row, E.C.—June 7, 1884.